CARDIOVIT AT-180

User Guide

SCHILLER
The Art of Diagnostics

Sales and Service Information

The SCHILLER sales and service centre network is world-wide. For the address of your local distributor, contact your nearest SCHILLER subsidiary. In case of difficulty, a complete list of all distributors and subsidiaries is provided on our internet site:

www.schiller.ch

Sales information can also be obtained from:
sales@schiller.ch

Headquarters Address

SCHILLER AG
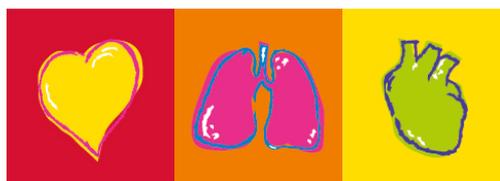Altgasse 68
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CE 0123

The CARDIOVIT AT-180 bears the CE-0123 mark (Notified Body TÜV-SÜD Product Service GmbH, Ridlerstr. 65, 80339 Munich, Germany), indicating its compliance with the essential requirements of the Annex I of the Medical Device Directive 93/42/EE regarding safety, functionality and labelling. The requirements apply to patients, users and third persons who come into contact with this device within the scope of its intended use.

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Contents

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1 Safety Notes

1.1 Intended Use

▲ The CARDIOVIT AT-180 is a multichannel ECG device intended to be used by trained medical professionals in healthcare facilities for the cardiological diagnosis in adult and paediatric patients.

▲ Analysis of the ECG is accomplished with algorithms that provide measurements, data presentations, graphical presentations, and interpretations for review by the user.

▲ Patient health information data is exchanged between the AT-180 and a data management system by USB memory stick, wired LAN or WiFi transmission

1.2 Indication of Use

▲ The CARDIOVIT AT-180 is a multichannel ECG device intended to acquire ECG signals from body surface electrodes and record, analyze, display and print ECGs for cardiological diagnosis in adult and paediatric patients.

1.3 Optional Use

▲ The following options can be sold with the CARDIOVIT AT-180:

– ECG interpretation algorithm ETM: assists the user in the evaluation of the ECG, providing various measurements derived from the ECG and interpretation statements.

– ETM Sport (included in ETM): assists the user in the evaluation of ECGs in athletes, providing various interpretation statements based on the Seattle Criteria.

– ECG re-measurement: allows the user to modify measurement points by means of callipers.

– Exercise Test: ECG acquisition during exercise performed on a treadmill or bike. The device provides continuous ST information for the diagnosis of acute cardiac syndromes.

– Arrhythmia detection: detects arrhythmias during exercise tests and resting rhythm acquisition.

– Signal averaging ECG: assists the user in the risk assessment/stratification of ventricular arrhythmia.

– Vector ECG: provides a 3-dimensional view on the electrical activity, and adds value to the diagnostic of the hearts backside

– 16-lead ECG: Increase the chances to detect posterior and left myocardial infarction with 4 additional electrodes.

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1.4   Characterisation of Users

▲ The CARDIOVIT AT-180 is intended to be used by trained medical professionals.

1.5   Characterisation of Patients

▲ The CARDIOVIT AT-180 is intended to be used for adult and paediatric patients.

1.6   Characterisation of Context of Use

▲ The CARDIOVIT AT-180 is intended for indoor use in healthcare facilities. The CARDIOVIT AT-180 must be used in the following environmental conditions.

– Temperature: 10 to 40 °C
– Humidity: 15 to 95% (non-condensing)
– Pressure: 700 to 1060 hPa

1.7   Contraindications

▲ The CARDIOVIT AT-180 is not designed:
– for sterile use
– for use in areas where there is any danger of explosion or in the presence of flammable gases such as anaesthetic agents
– for direct cardiac application

– for use in an MRI suite (MR).

– for use with high frequency surgical units.

1.8   Responsibility of the User

▲ This device must only be used by qualified physicians or trained medical personnel.

▲ The numerical and graphical results and any interpretation given must be examined with respect to the overall clinical condition of the patient and the general recorded data quality.

▲ The indications given by this equipment are not a substitute for regular checking of vital functions.

▲ The responsibilities of the personnel for the operation and maintenance of the device must be specified.

▲ Ensure that personnel have read the operating instructions of the CARDIOVIT AT-180 and the operating instructions of any ancillary equipment, especially an ergometer. In particular the safety instructions of the device and the ergometer must be read and understood.

▲ Damaged or missing components must be replaced immediately.

▲ The operator is responsible for compliance with all applicable accident prevention regulations and safety regulations.

▲ The safety, reliability and performance of the device can only be guaranteed when the maintenance intervals as stated in the maintenance section are observed.

▲ It is the responsibility of the user to ensure adequate data backup.

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1.9   Safety Facilities

▲ Operating the device without the correctly rated fuse or with defective cables constitutes a danger to life! Therefore:

– Do not operate the device if the earth connection is suspect or if the mains lead, the power supply unit or the device is damaged or suspected of being damaged.
– Damaged cable connections and connectors must be replaced immediately.
– Electrical safety devices, such as fuses, must not be modified.
– Fuses must only be replaced with the same type and rating as the original.

1.10   Organisational Measures

▲ Before using the device, ensure that an introduction regarding the device functions and the safety precautions has been provided by a medical product representative.

▲ Observe the operating and maintenance instructions. Keep all instructions in an accessible place for reference when required. Make sure that they are always complete and legible.

▲ In addition to this user guide, legal and other binding regulations for the prevention of accidents and for environment protection must be observed.

1.11   Safety-conscious Operation

▲ ⊣♥⊢ This device is CF classified and defibrillation protected only when the original patient cable is used. However, as a safety precaution when possible, remove electrodes before defibrillation.

▲ Ensure that the patient is informed about the procedure for stress testing and is aware of the risks (for example, of falling on a running treadmill). Ensure the patient is aware of the location and use of the emergency stop knob when using a treadmill.

▲ Do not touch the device casing during defibrillation.

▲ To ensure patient safety, none of the electrodes including the neutral electrode, nor the patient or any person with simultaneous patient contact, must come in contact with conductive parts, even when these are earthed.

▲ Immediately report any changes that impair safety (including operating behaviour) to the person responsible.

▲ Do not place any liquids on the device. If liquid should be spilled over the device, immediately disconnect the device from the mains and wipe it. The device must be checked before reusing.

▲ Only connect the original SCHILLER patient cable to the patient socket.

▲ If the patient cable should become defective after defibrillation, an electrode becomes displaced, or an electrode resistance is too high, a lead-off indication is displayed.

▲ Only use accessories and disposables recommended or supplied by SCHILLER. Use of other than recommended or supplied parts may result in injury, inaccurate information and/or damage to the device.

▲ Only operate the device in accordance with the specified technical data.

▲ There is no danger for patients with pacemaker. However to prevent pacemaker malfunction, a distance of at least 30 cm must be observed between the device and the pacemaker to prevent any interference from the WiFi (wireless LAN) module.

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1.12   Transporting & Placement

▲   Be cautious when moving the device. In particular, if the device is placed on a trolley, quick stops, excessive forces and uneven surfaces may cause the trolley to overturn thus risking the device to fall to the ground.

▲   If the device falls to the ground, turn the power off immediately and disconnect from the mains. Contact a SCHILLER approved service centre. Continued use of the device can result in fire or electric shock.

1.13   Operation with other Devices

▲   Ancillary equipment connected to any analogue and/or digital interface of the device must be certified according to the respective IEC standards (e.g. IEC/EN 60950 for data processing equipment and IEC/EN 60601-1 clause 16 for medical equipment). Furthermore all configurations shall comply with the current version of the system standard IEC/EN 60601-1 clause 16. Anybody who connects additional equipment to the signal input part or signal output part configures a medical system, and is therefore responsible that the system complies with the requirements of the valid version of the system standard IEC/EN 60601-1. If in doubt, consult the technical service department or your local representative.

▲   Any other equipment used with the patient must use the same common earth as the CARDIOVIT AT-180.

▲   Precautions must be observed when using high frequency devices. Only use the original patient cable to help avoid possible signal interference during ECG acquisition.

▲   There is no danger when using the ECG device simultaneously with electrical stimulation equipment. However, the stimulation units should only be used at a sufficient distance from the electrodes. If in doubt, the patient should be disconnected from the device.

▲   If the device is a part of a medical system, the original SCHILLER patient cable must only be used with, and connected to, the patient connector on the CARDIOVIT AT-180.

▲   If the patient cable should become defective after defibrillation, a lead-off indication is displayed on the screen.

▲   Portable communication devices, HF radios and devices labelled with the ((( ))) symbol (non-ionic electromagnetic radiation) can affect the operation of this device.

1.14   Network Security

▲   When the CARDIOVIT AT-180 is part of a network (LAN, WLAN, HIS, etc.), the operator of the network/data coupling must take appropriate security measures to protect the transmission of data. Networks that are not protected and maintained can lead to failure of the data transmission or to incorrect transmission of data, which in turn can result in danger to the patient.

▲   For further safety notes (see para. 12, Transmission, page 111).

1.15   Maintenance

▲   Danger of electric shock. Do not open the device. No serviceable parts inside. Refer servicing to qualified technician authorised by SCHILLER only. This includes batteries that can only be changed by service personnel with the use of a special tool. Battery replacement by inadequately trained personnel could result in excessive temperatures, fire or explosion.

▲   Before cleaning and to isolate the mains power supply, switch the device off and disconnect it from the mains by removing the plug.

▲   Do not use high temperature sterilisation processes (such as autoclaving). Do not use E-beam or gamma radiation sterilisation.

▲   Do not use solvent or abrasive cleaners on either the device or cable assemblies.

▲   Do not, under any circumstances, immerse the device or cable assemblies in liquid.

1.16   Electrical and Power Source Related

▲   To avoid the risk of electric shock, this equipment must only be connected to a mains supply with protective earth.

▲   Operating the device without the correctly rated fuse, or with defective cables, constitutes a danger to life. Therefore:
   – Do not operate the device if the earth connection is suspect or if the mains lead is damaged or suspected of being damaged.
   – Damaged cable connections and connectors must be replaced immediately.
   – The electrical safety devices, such as fuses, must not be altered.

▲   Ruptured fuses must only be replaced with the same type and rating as the original.

▲   Only use power cords provided by the dealer to ensure safety and EMC compliance.

▲   The CARDIOVIT AT-180 device must be connected to an approved power source as shown on the specification label.

▲   The power cords must not be damaged. Applied pressure, heat, and stress can damage the power cord.

▲   The power cords must be routed properly so as to help prevent people from stepping on the cords or the cords being run over by, for example, the trolley

▲   Do not overload the mains outlet or extension cords. Electrical shocks or fires may occur from overloading.

▲   Do not touch the power source during a thunderstorm.

▲   If your hands are wet, do not touch the plug.

▲   Do not pull the power cord to remove it from the mains socket because this can damage the cable. Use your thumb and index finger to grip the plug itself.

Non ionising electromagnetic radiation, may cause or be susceptible to electromagnetic disturbances. The device contains an HF transmitter (WiFi).

The CARDIOVIT AT-180 radiates high-frequency electromagnetic energy and can disturb other devices if not installed and operated in accordance with the specification. However, there is no guarantee that no interference can occur in certain installations. If the CARDIOVIT AT-180 causes interferences, these can be determined by switching the device off/on or by transmitting/not transmitting ECG data. The user can take the following measures to solve this problem:

• Increase the distance between the disturbed device and the CARDIOVIT AT-180. A minimum distance of 30 cm must be kept between the device and a pacemaker.
• Turn the device to change the angle of radiation.
• Connect the device to a different mains connector.

This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to both Part 15 of the FCC (Federal Communications Commission) Rules and the radio interference regulations of the Canadian Department of Communications. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with this instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

1.17   Safety Symbols and Pictograms

1.17.1   Symbols Used in this Document

The safety level is classified according to ISO 3864-2. The following overview shows the safety symbols and pictograms used in this manual.

⚠ DANGER   For a direct danger which could lead to severe personal injury or to death.

⚠WARNING   For a possibly dangerous situation which could lead to severe personal injury or to death.

⚠ CAUTION   For a possibly dangerous situation that could lead to personal injury. This symbol is also used to indicate possible damage to property.

For general safety notes as listed in this chapter.

For electrical hazards, warnings or precautionary measures when dealing with electricity.

i   **Note** For possibly dangerous situations which could lead to damage to property or system failure. **Important** or helpful user information.

Reference to other instructions.

1.17.2   Symbols Found on the Device Type Label

The following is a typical label found on the Device.
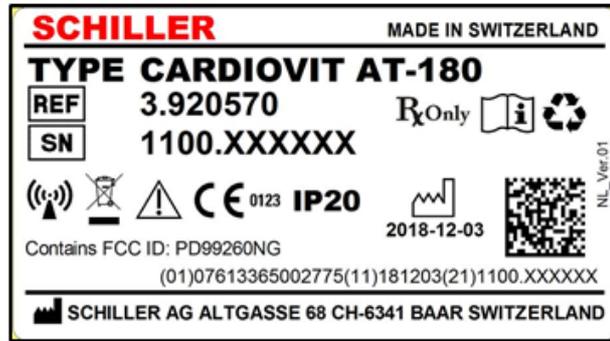
CE 0123	Notified body of the CE certification (TÜV P.S.).
RxOnly	Federal law (USA) restricts this device to sale by or on the order of a physician
((•))	May cause or be susceptible to electromagnetic disturbances.
IP20	According DIN VDE 0470 PART 1 /EN 60529 / IEC 529
	Protection against deposits of dust and protection against spray water. (The first digit indicates the protection of the equipment against ingress of solid foreign bodies and dust and the second digit indicates the degree of protection of the equipment inside the enclosure from ingress of water).
	Manufacturer: SCHILLER AG, CH-6341, Baar
20xx-02-24	Date of Manufacture
REF SN	Reference and serial number of the device.
⚠	Attention: Applied parts. Consult accompanying documents.
	Symbol for the recognition of electrical and electronic equipment.
	Equipment/components and accessories no longer required must be disposed of in a municipally approved collection point or recycling centre. Alternatively, you can return the equipment to your supplier or SCHILLER for disposal. Improper disposal can harm the environment and human health.

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The device/component can be recycled.

Internal battery type Li-Ion. Do not disassemble, mutilate, incinerate, or heat. Do not short circuit a battery. May cause burns.

At the end of the unit's life do not dispose in household waste. Batteries must be disposed of in an approved collection point or recycling centre.

Read the user guide.

1.17.3   Symbols Found on the Device

CF symbol. The device's signal input is defibrillation-proof. CF symbol. This device is classified safe for internal and external use. However, It is only defibrillation protected when used with the original SCHILLER patient cable.

Potential equalisation

Network

Safety control sticker detailing the date of the next planned maintenance that must be observed.

Read and follow the instructions in the accompanying documentation.

Input / Output (IEC 60878).

2 Introduction

The SCHILLER CARDIOVIT AT-180 is a multi-channel ECG device designed to record, display and measure resting ECGs, signal averaged ECGs (optional), and exercise ECGs (optional) and can be operated with mains power or with an internal battery.

2.1 Standard Features and Editing Functions

- Patient demographic query (PDQ)
- Worklist
- Resting ECG
- Resting ECG measurements
- Manual rhythm printout in real time
- Resting rhythm up to 20 minutes
- Pacemaker detection
- Lead quality check
- Lead reversal detection
- Memory
- WiFi and LAN
- Bi-directional connectivity with HIS, PACS, EMR systems via Schiller Server
- Schiller Link

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2.2   Options

- 16 lead ECG recording (in combination with 14-wire patient cable)
- Arrhythmia Detection (exercise and rhythm recording).
- ETM Interpretation - computer-aided ECG interpretation for adults and paediatric patients.
  – ETM Sport - based on the Seattle Criteria
  – Resting ECG Re-Interpretation

- Exercise Test - ECG acquisition during exercise performed on a treadmill or bike. The device provides continuous ST information for the diagnosis of acute cardiac syndromes.
- ECG re-measurement - allows the user to modify measurement points by means of callipers.
- Vector cardiogram (3D) - ECG displayed as vector loops.
- Signal Averaged ECG.

2.3   Back Panel

a   b   c   d   e   f   g   h
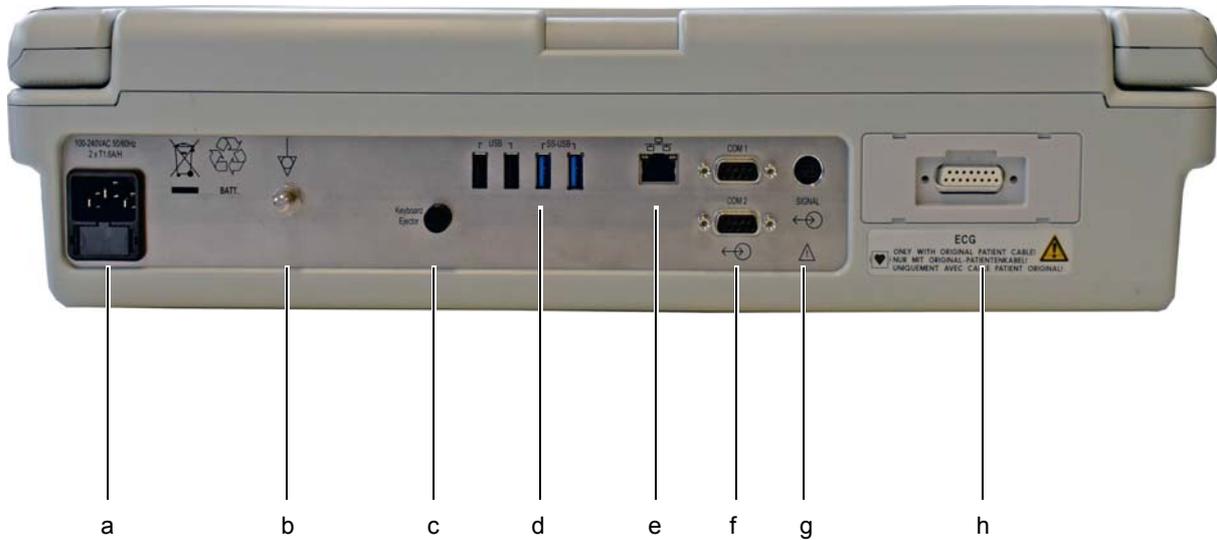
| **⚠ CAUTION** | ▲ All externally connected hardware must be approved by SCHILLER. Connection of any hardware not approved by SCHILLER is at the owner's risk and may invalidate the guarantee. |

(a) Mains connector and fuses (100-240 VAC, 50/60Hz, 2 x T 1.6 AH).

(b) Potential equalisation stud. The potential equalisation stud is used to equalise the ground potential of the unit to that of any nearby mains powered equipment. Use the hospital or building common ground for all mains powered devices.

(c) Keyboard ejector to facilitate keyboard cleaning and replacement.

(d) USB connectors: USB 2 (x2) and USB 3 (x2) for connection of external USB devices, for example USB mouse, barcode reader, memory stick, etc.

(e) Network connector RJ-45 Ethernet LAN connector (Local Area Network)

 (f) RS-232 connectors:
   – COM 1 is used for a treadmill / ergometer
   – COM 2 is used for an NIBP device (for example BP-200 plus).

(g) QRS trigger output (for example for the BP-200 plus).

(h) ECG patient cable connector.

| ⚠ | ▲ The patient cable as well as the connector comply with the safety standard CF ⊣♥⊢, fully floating and isolated, defibrillation protected and suitable for the intracardiac application. This device is only CF rated and defibrillation protected when used with the original patient cable. |
| | ▲ Do not remove the connector when the electrodes are applied to the patient. |

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2.4   Start-up and Initial Preparation

⚠ **DANGER**

⚡

▲   Danger of electrical shock. Do not operate the device if the earth connection is suspect or if the mains lead is damaged or suspected of being damaged.

2.4.1   Location

- Do not keep or operate the device in a wet, moist, or dusty environment. Avoid exposure to direct sunlight or heat from other sources.
- Do not allow the device to come into contact with acidic vapours or liquids.
- The CARDIOVIT AT-180 should not be placed in the vicinity of X-ray or diathermy devices, large transformers or electric motors. It must also be positioned at least one meter from the mains supply.
- The electro-radiation limits of other devices are given in the Technical Data Section.

2.4.2   Connection of Cable Assemblies and Ancillary Equipment

1. Connect the patient cable (back panel).
2. Connect any ancillary and optional equipment (see previous page). These may include the following:
   - Ergometer (digital) for exercise testing
   - Blood pressure device
   - Network cable
   - External printer
3. Connect the power cable at the rear of the device. The Mains indicator lamp is lit.

2.4.3   Potential Equalisation

The potential equalisation stud at the back of the device is used to equalise the ground potential of the CARDIOVIT AT-180 to that of all mains-powered equipment in the vicinity. Use the hospital or building common ground. A yellow/green earth cable is supplied as an option (article number 2.310005).

⚠ **WARNING**

▲   Danger of triggering ventricular fibrillation. If the CARDIOVIT AT-180 is used together with devices that are designed for direct cardiac application, both devices must be connected to the hospital/building common ground (potential equalisation) to prevent current flow between different device potentials.

2.5   Touch Screen Operation

The touch sensitive display operates in the same manner as a mouse. Menu options are selected by touching the item:

Select and Open a Menu Item

Menu options and display icon functions are selected by touching the item.

Double Click Functions

Double click functions are initiated by touching the item twice in quick succession. Use this, for example to open a recording in the memory screen.

Scrolling

When viewing a recording, rhythm strips can be scrolled using a finger.

2.6   Keypad Control Keys and Indicators
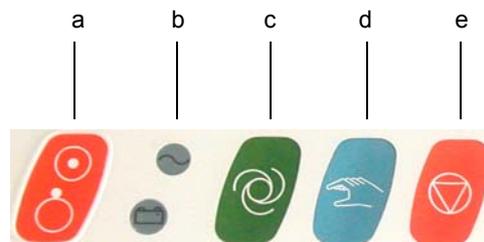
(a) **On/Off key**

(b) **Power indicators** - mains and battery. The mains indicator shows that mains is connected: the battery lamp indicates that the device is running on battery power or charging (see para. 2.12.1, Mains and Battery Indicators, page 31).

(c) **Auto key** - Take an ECG recording in auto mode.

(d) **Manual key** - Continuous printout of ECG.

(e) **Stop key** - Stop printout, run paper to start position.

2.7   Switching On the Device

The device is switched on and off with the **On / Off** key.

The login screen and the first screen displayed are defined is system settings (see para. 13.7.9, Workflow, page 132).

2.8   Switching Off the Device

• Press the On / Off key. You are prompted to confirm:

Turn off device   ?

Are you sure you want to turn off the device?

        [Yes]   [No]

• Select logout from the main menu, and select Shutdown (only available when the device is set for user login - see next page).
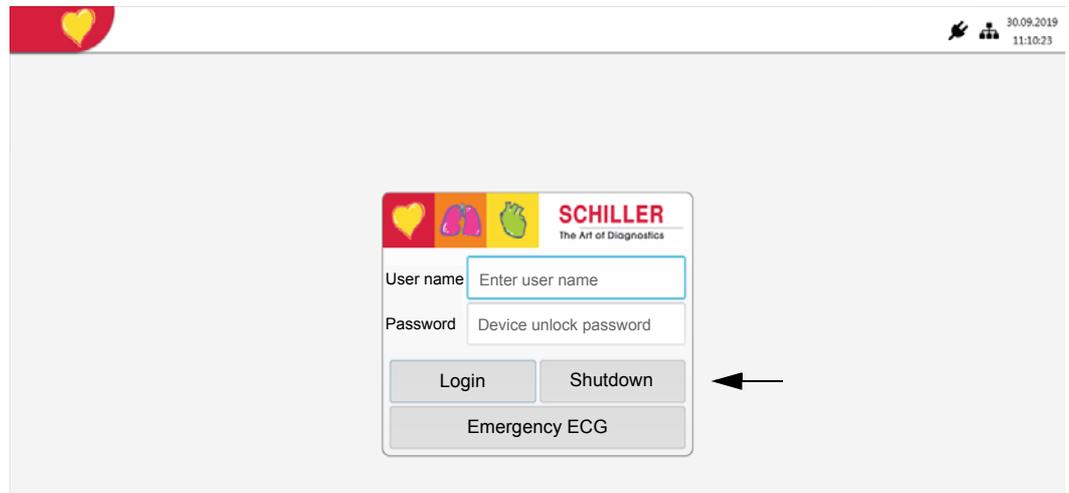
There is also an auto switch-off option (see para. 13.7.3, Power Management, page 129). that switches the device off after a defined period of inactivity. (Different power measurement settings can be defined for when the device is operating on battery power and for when the device is plugged in).

Automatic shutdown   i

The device will shutdown automatically in 28 seconds due to inactivity

Press any key to cancel automatic shutdown
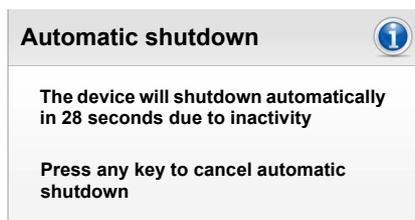
2.9   Logging In

When the device is switched on, the user login screen is displayed (or the program is entered directly, see notes below).
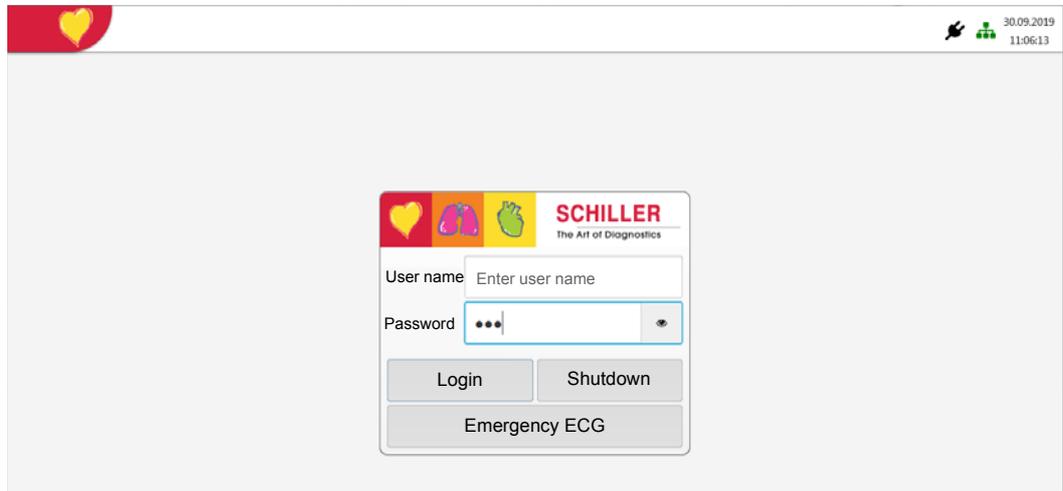
Enter your user name and password.

Notes:

- User login is a system setting and user login can be set as follows:
    - **None** - no user or password required and the program is entered directly on switch-on.
    - **Basic** - two access levels to access device (recording), or settings. Password required for each.
    - **Local** - user and password defined locally in settings
    - **SCHILLER Server** - user and password defined by SCHILLER server.
    - (see para. , Plugged in, page 129).

- When Local is defined, only locally defined users can log-in. When SCHILLER Server is defined, only users that are defined by the server can log-in.
- If **Emergency ECG** is selected, login is bypassed and the ECG acquisition screen is entered directly. An emergency patient ID is defined.
- After login, the first screen to be displayed (see next paragraph) is defined in system settings (see para. 13.7.9, Workflow, page 132).
- User roles and privileges are assigned to individual users and that can affect access to a workflow area and the functions that can be carried out. If a function is not available, it means that the user logged in does not have the privileges required. Individual users, and the user groups and privileges defined for individual users are defined by the SCHILLER Server or locally if not networked.

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2.10 Display Overview

The display will vary according to the task being carried out. However, the top information area is the same in all screens and the bottom line and the left-hand area always display information and function options applicable to the screen that is displayed.

Access to the main menu (see para. 2.11, Main Menu Overview, page 30):

– Worklist
– Recorder
– Memory
– Settings
– Maintenance

Patient data

Date and time

Local Storage capacity

Network status (hover over for details)

Battery/mains status (see para. 2.12.1, Mains and Battery Indicators, page 31)

User (hover over for details)

Export status (see para. 2.13.2, SCHILLER Server, page 32)

	12.12.1965-smith					
	Smith Robert | 56 years | male				26.06.2019 17:38	

Patient ID	1234-85-11-sch	Visit ID	
First name	Fred	Height (cm)	176
Last name	Schmid	Weight (kg)	76
DOB	23.11.1985	Ethnicity	Undefined
Gender	Male	Pacemaker	Unknown
Digitalis		Referring Physician	
Room		Attending Physician	
Indication		Remarks	

PDQ	SAECG	Exercise	Resting

Function icons - icons will change according to the screen displayed.

Bottom row function icons will change according to the screen displayed.

2.11   Main Menu Overview

Main menu

- Worklist
- Recorder
- Memory
- Settings
- Maintenance
- Lock
- Logout
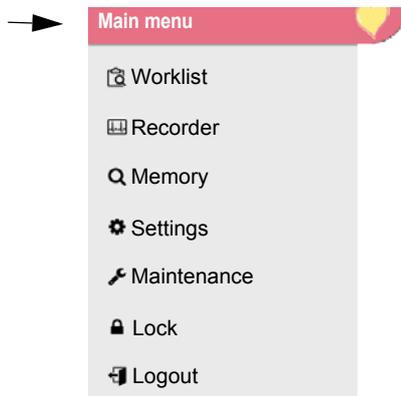
Worklist

Enter this screen to search for work items for all or selected patients or groups of patients. Work orders can be ordered by patient, priority, order ID, etc.

Recorder

Select this screen to enter a new patient and proceed the ECG screen to take a recording.

Memory

In this screen you can search for a recording by PID, Visit ID or name. Recordings can be listed by time and date, last name, patient ID, visit ID or synchronisation state.

Settings

Here all the system settings are made including time / date, language, connectivity, ergo devices, etc.

Maintenance

This provides maintenance and system checks - details are provided in the AT-180 service handbook.

Lock

This locks the device for the current user and only the current user can log in again.

Logout

This logs out the user and any another user can log in.

ℹ️ **Notes:**

- The first screen displayed on login is the **Worklist** or the **Recorder** screen(see para. 13.7.9, Workflow, page 132). When the Recorder screen is entered, the patient data screen is always initially displayed (see para. 2.16, Patient Data, page 35).
- The **Lock and Logout options** are available when the current user has logged-in (with a password). These options are not available when user authentication is not active.

2.12   Power Supply

This device can be operated from the mains supply or from the built-in rechargeable battery. The internal battery provides power for up to four hours of general use. The current power source is displayed on the mains battery LED indicator and also in the top right of the screen.

Mains Connected

The batteries are charged by a internal power supply when mains is connected during operation and when the device is switched off. When the mains supply is connected, the mains LED is illuminated. When the battery is recharging both mains LED and the battery indicator LED are illuminated.

Mains Interrupted

If the mains supply is interrupted, the device automatically switches over to battery operation (see next page). The user settings are maintained.

2.12.1   Mains and Battery Indicators

LED Indicators on the device

The LED indicators on the device casing indicate the power operation as follows:

Function	Battery LED	Mains LED
Mains Connected:		
Battery Charging	• On	• On
Battery Full	• Off	• On
Battery Working:	• On	• Off
Battery capacity limited	• Blinking	• Off

Power Symbols on the screen

The power indicators in the program indicate power operation as follows:

• Mains supply:

• Battery supply:

Battery Capacity

Full

Medium full

Capacity limited

Empty

When the device is running on battery power (mains not connected), the battery symbol indicates the battery status. When the battery is full the symbol is solid. When running on battery power and the battery capacity is limited, the battery symbol changes to red and the message appears on the screen:

Automatic shutdown ☒

Battery low! Please connect power supply or device will automatically shut down in 20 seconds
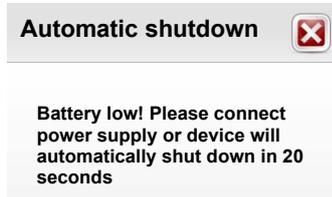
If mains is not connected the device switches off.

2.12.2   Battery Charging

The battery is charged when the device is connected to the mains supply. The device can remain connected to the mains supply without damage to either the battery or the device.

2.12.3   Isolating the Mains Supply

To isolate the power supply, remove the mains plug from the wall socket.

2.13   Saving and Exporting Recordings

Recordings are saved on the Device memory and can be exported in PDF format to a USB memory. When the device is networked, recordings can be exported via Schiller Server or Schiller Link.

2.13.1   Recording Memory

Memory capacity is indicated by the icon in the status bar:

- green = memory OK
- yellow = almost full
- red = memory full, no more recordings can be performed

2.13.2   SCHILLER Server

Connection with the Server

Connection to the SCHILLER Server is indicated in the top right of the screen. Hovering over the symbol will indicate the server connection, for example:

Connected to:
https://schillerserver.stmary.com:8181/SemaServer

The network symbol has three states as follows:

- Symbol Green - Connected to network and SCHILLER Server
- Symbol Black - Connected to network but no connection with SCHILLER Server
- Symbol black and a cross in the symbol - no network connection

Wifi Connection

When Wifi is set, the symbols are as follows:
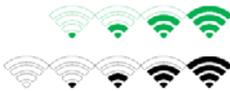
- Symbol Green - Connected to Wifi network and SCHILLER Server.
- Symbol Black - Connected to network but no connection with SCHILLER Server
- The strength of the signal is indicated with the number of bars.

2.13.3 Automatically Exporting Recordings After Recording

Recordings can be exported automatically to a server after they have been accepted. This is defined in system settings Main Menu > Settings > Workflow > Transmit after save (see para. 13.7.9, Workflow, page 132).

- When the Export function is active, and all recordings have been successfully exported, the export symbol in the top right of the screen is ticked.
- If for any reason a recording cannot be exported, it remains stored locally and indicated by the number of recordings that have not been successfully exported.

2.13.4 Manually Exporting Recordings

Select the recording(s) to be exported in the memory and select the export icon in the side bar

Recordings are exported from the memory screen (see para. 10, Memory, page 106).

The location where the recordings are exported is defined in system settings (see para. 13.5.1, EMR Integration, page 126).

2.13.5 PDF Export

A PDF file of a recording can be made when a recording has been accepted. Recordings are transmitted to a USB memory. The setting to generate a PDF file is defined in system settings Main Menu > Settings > Workflow > PDF to USB after save (see para. 13.7.9, Workflow, page 132).

The PDF symbol has two states as follows:

- When the PDF export function is active (and there are no recordings saved in memory for export), the PDF export symbol in the top right of the screen is ticked.
- If a memory stick is not connected and recordings are stored locally, the number of recordings that have not been exported are indicated. When a memory stick is connected, recordings are automatically exported.

2.14 System Settings

System settings (time, date, Device-ID etc.), general system settings, communication along with ECG and other settings are defined in system settings. (see para. 13, Settings, page 116).

2.15   Replacing the Print Paper

Important

The device is delivered without printing paper inserted. The thermal paper is sensitive to heat, humidity and chemical vapours. The following points apply to both storage, and when archiving the results:

• Before use, keep the paper in its original packaging.

• Store the paper in a cool, dark and dry location.

• Do not store near chemicals, e.g. sterilisation liquids.

• Do not store in PVC folders or envelopes made of recycled paper.

• Certain glues can react with the paper. Therefore, do not use glue to attach the printout onto a mounting sheet.

SCHILLER can only guarantee perfect printouts when original SCHILLER chart paper is used.

It is recommended that the device is switched off when the paper is being replaced.

A red strip on the bottom edge of the recording paper indicates that the paper is limited. When this strip appears, there are about ten pages left. We recommend that the paper be replaced as soon as this indication appears

To replace the paper, proceed as follows:

1.   Place fingers on the retaining bar flap and push to release the paper tray cover. Do not force, the paper tray runs freely on dedicated runners. Remove any remaining paper from the paper tray.

2.   Place a new paper pack into the paper tray with the printed (grid) side facing upwards and the black paper marks towards the rear of the device.

3.   Take the first sheet and place the beginning of the paper over the roller. Ensure that the printed grid side is facing upwards.

4.   Return the paper tray in position and press firmly until secure. Switch the device back on and press the **Stop** key to transport the paper to the start position.

Roller

Paper Mark
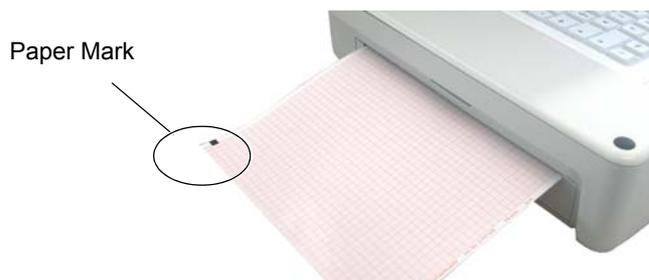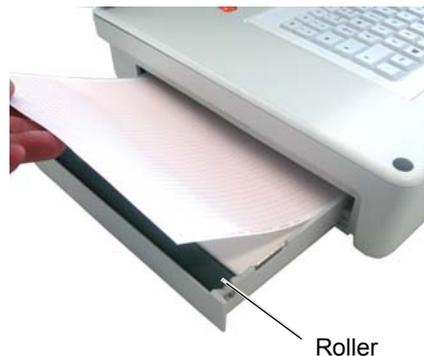
2.16   Patient Data

The patient data screen is displayed from the Recorder screen, and is the first screen displayed on entering **Recorder**.

i   If a recording is performed without having entered the patient ID, a UUID is generated instead of a patient ID, 'Emergency ECG' is given instead of a last name, and the date and time are given instead of a first name. If you want to enter patient data once the recording has been performed (and before it has been accepted), you can jump to the Patient data screen by pressing the Patient key, enter the data and use the Review key to jump back to the recording to accept (save) it.

Patient data

Patient ID	Enter the patient's identification number
Last name	Enter patient's name (maximum 50 characters)
First name	Enter patient's first name
DOB	Enter the patient's date of birth
Gender	Enter the patient's gender - Male, Female, Other or Undefined.
Digitalis	Check if the patient is taking digitalis medication
Room	Enter room
Indication	Medication, reason for medication, or other patient indications
Visit ID	Enter Visit ID as required
Height	Enter the patient's height
Weight	Enter the patient's weight

Ethnicity   Select one of the following:

- Undefined
- Caucasian
- Asian
- Black / African American
- American Indian / Alaska Native
- Native Hawaiian / Pacific Islander
- Hispanic
- Oriental
- North East Asian
- South East Asian
- Other

i   After a recording has been accepted (saved) the patient data cannot be edited or changed. When a recording has been taken and is still open for editing, patient data can be changed. If the patient's date of birth is changed, or the Digitalis box checked it can affect the interpretation of the recording and you are prompted to re-analyse the recording:

> Reinterpretation recommended
> Relevant data has changed:
> · Digitalis medication

No changes can be made to the interpretation after it has been validated.

Pacemaker   Select if the patient has a pacemaker (Yes/No/Unknown).

i   • **Pacemaker detection** in all preview screens is always **OFF by default**. Pacemaker detection is activated with the Pacemaker detection icon in the side function bar.

• Detected pacemaker pulses are indicated in blue and the interpretation states that it is a pacemaker ECG.

Referring physician   Referring physician

Attending physician   Attending physician

Remark   Remarks about the patient/recording

i   • A setting is available to require that certain patient data fields must be entered before a recording is taken. Different data can be defined for different recording types. This is defined in system settings (see para. 13.7.6, Mandatory Fields, page 131).

• The format of the date of birth, and the units used for height and weight can be changed in system settings (see para. 13.6, Regional, page 128).

Actions

✖ Clear   Delete patient data.

Use previous patient   The previous patient's data is entered again.

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2.16.1   Patient Data Query (PDQ)

When the device is connected to an EMR system or hospital patient database (via network or WLAN), patient data can be filled in automatically when the **Patient ID** or **Visit ID** is entered. This is called **Patient Data Query** or **PDQ**.

➜   Enter the patient ID or visit ID and press the **PDQ** key   PDQ   or OK to confirm the patient data query.

PDQ with Barcode Reader

➜   Scan the barcode to enter the **Patient ID** / **Visit ID**. Patient data is filled in automatically when the **Patient ID**/**Visit ID** is read with a barcode reader.

•   Connect the barcode reader
•   Barcode scanner configuration: see document 2.510721.

2.16.2   Barcode Reader

A barcode reader can be attached to the USB port on the back panel to read the Patient ID / Visit ID. SCHILLER has tested the following barcode reader:

➜   Symbol Model LS 2208, from Symbol Tech N.Y.

When a barcode reader is connected, the patient data is read from the barcode (generated by the hospital system). If an external hospital patient database is available, all patient data is entered in the patient data fields of the CARDIOVIT AT-180 as described on the previous page.
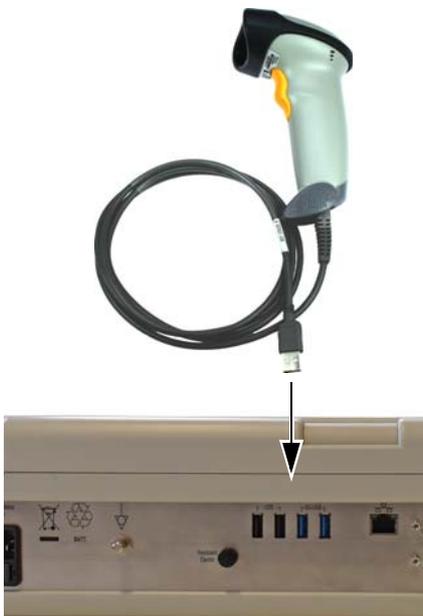
3 ECG Cable and Electrode Placement

3.1 Cables

A 10-wire patient cable is standard, and a 14-wire patient cable is available as an option. When licensed, the lead configurations supported with the 14-wire cable are available for selection.

Both cables are available as banana or clip connections. Part numbers of the cables are detailed in the Accessories section .

3.2 Electrode Identification and Colour Code

The electrode placements shown in this Section are labelled with the colours according to Code 1 requirements.

Lead System	Code 1 (Usually European)		Code 2 (Usually American)	
	Electrode Identifier	Colour code	Electrode Identifier	Colour code
Limb	R	Red	RA	white
	L	Yellow	LA	Black
	F	Green	LL	Red
Chest according to Wilson	C	White	V	Brown
	C1	White/Red	V1	Brown/Red
	C2	White/Yellow	V2	Brown/Yellow
	C3	White/Green	V3	Brown/Green
	C4	White/Brown	V4	Brown/Blue
	C5	White/Black	V5	Brown/Orange
	C6	White/Violet	V6	Brown/Violet
Neutral	N	Black	RL	Green

14-Wire Patient Cable

As above plus the following four extra electrodes:

Schiller Electrode Identifier	Code 1 (IEC Colour Code)	Code 2 (AHA Colour Code)
A1	Light blue / violet	Orange / violet
A2	Light blue / yellow	Orange / yellow
A3	Light blue / red	Orange / red
A4	Light blue /black	Orange /black

3.3   Electrode Placement Basics

⚠️**WARNING**

▲   Ensure that neither the patient nor the leading parts of the patient connection nor the electrodes (including the neutral electrodes) come in contact with other persons or conductive objects, even when these are earthed.

Careful application of the electrodes is important for a good ECG recording. A minimal resistance between skin and electrode is required to obtain the best ECG signal and ensure the highest quality ECG recording. Therefore please note the following points:

1.   Only use electrodes recommended by SCHILLER.
2.   Check the expiry date on the electrode packaging. Ensure that the electrodes are within date.
3.   To ensure the electrode's conductivity and adherence:
     –   If necessary, shave the application areas.
     –   Thoroughly clean the area with alcohol or soap and water before applying the electrodes.
     –   Thoroughly dry the electrode area before applying the electrodes.
     –   When applying the electrodes, ensure that a layer of gel is between the electrode and the skin.[1]

4.   After the electrodes have been applied, the skin electrode resistance can be checked on the screen.
5.   If electrode contact is not within tolerance:
     –   Remove the electrode and clean the skin area.
     –   Use an abrasive pad or proprietary abrasive cleaning gel[2] to remove the upper layer of the epidermis.
     –   Reapply the electrode. Always use a new electrode when single-use electrodes are used.
6.   Ensure that the patient is warm and relaxed before you start the recording.
7.   After the recording, remove the electrodes. Clean suction and vacuum reusable electrodes and remove any remaining gel according to the instructions given by the manufacturer.

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1.   Electrode gel is integral with single-use electrodes and extra gel does not need to be applied when single-use electrodes are used. For biotab single-use electrodes solid conductive gel is incorporated in the adhesive.
2.   Abrasive cleaning gel will help reduce skin resistance and achieve good results.

3.4   Lead Selection and Configurations

The lead configurations that are available for selection are set in system settings - Main menu > Settings > ECG > Lead and Cable (see para. 13.2.1, Lead & Cable, page 119). Note: The 14-lead configurations are only available for selection when this option is licensed.

The lead configuration can be changed before starting a recording.

The lead configurations available for selection in the acquisition screen will depend on the following:
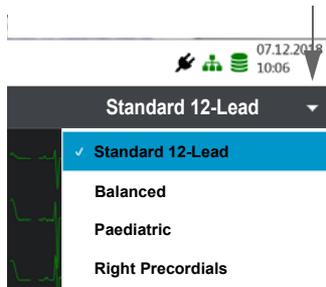
- The type of recording entered (Resting, Exercise, SAECG)
- The lead configurations defined in system settings
- The patient cable connected

i

- Electrode placement assistance and electrode check is additionally given in the ECG acquisition screen (see para. 4.4.2, Electrode Placement, page 54)
- The electrode resistance is constantly monitored in the recording screen and a lead-off indication displayed if the resistance is too high.

3.5   Standard 12 Lead
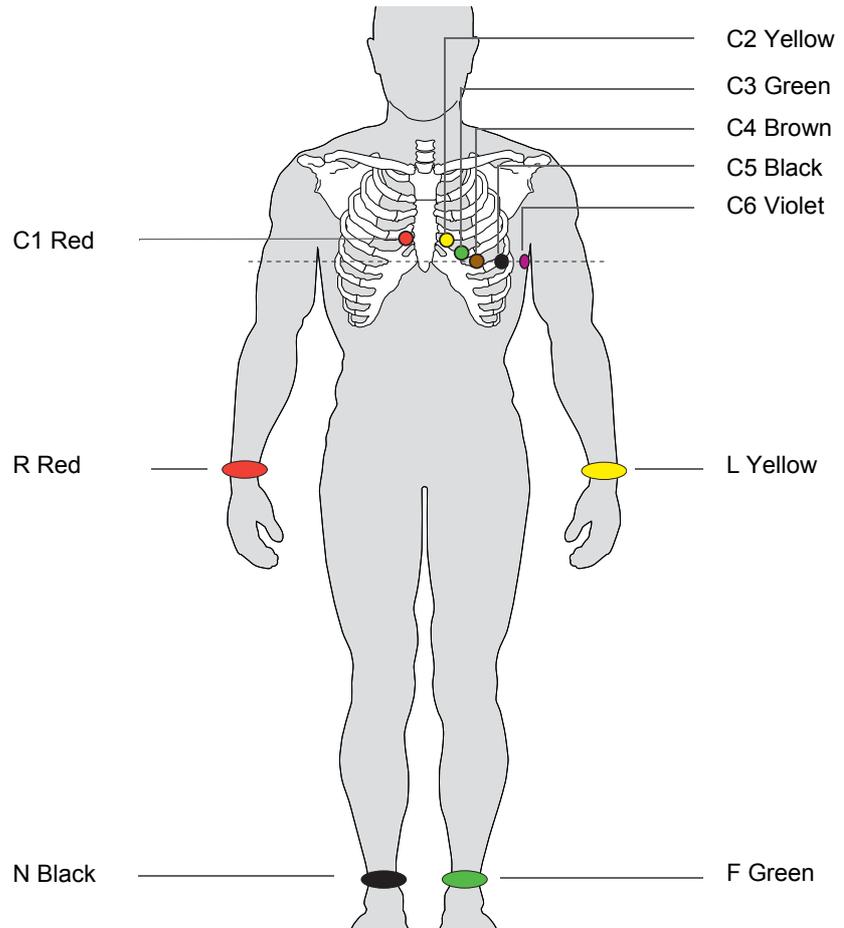
IEC Label	AHA Label		Electrode Placement
C1 white / red	V1 brown / red	➜	Fourth intercostal space at the right sternal border
C2 white / yellow	V2 brown / yellow	➜	Fourth intercostal space at the left sternal border
C3 white / green	V3 brown / green	➜	Midway between C2 and C4
C4 white / brown	V4 brown / blue	➜	Left mid-clavicular line in the fifth intercostal space
C5 white / black	V5 brown / orange	➜	Left anterior axillary line on the same horizontal level as C4
C6 white / violet	V6 brown / violet	➜	Left mid-axillary line on the same horizontal level as C4
L yellow	LA black	➜	Left arm
R red	RA white	➜	Right arm
F green	LL red	➜	Left foot
N black	RL green	➜	Right foot

ℹ
- Auto Interpretation is only generated when standard electrode lead configuration is set.
- When making an ECG with a child it is sometimes physically difficult to position all electrodes. When this is the case electrode C4 can be placed on the right side of the chest (or the Paediatric configuration can be set).

3.6   Balanced

C7 (C4 Brown)
C8 (C5 Black)
C9 (C6 Violet)

C4r (C3) Green
C3r (C2 Yellow)
C1 Red

R Red

L Yellow

N Black
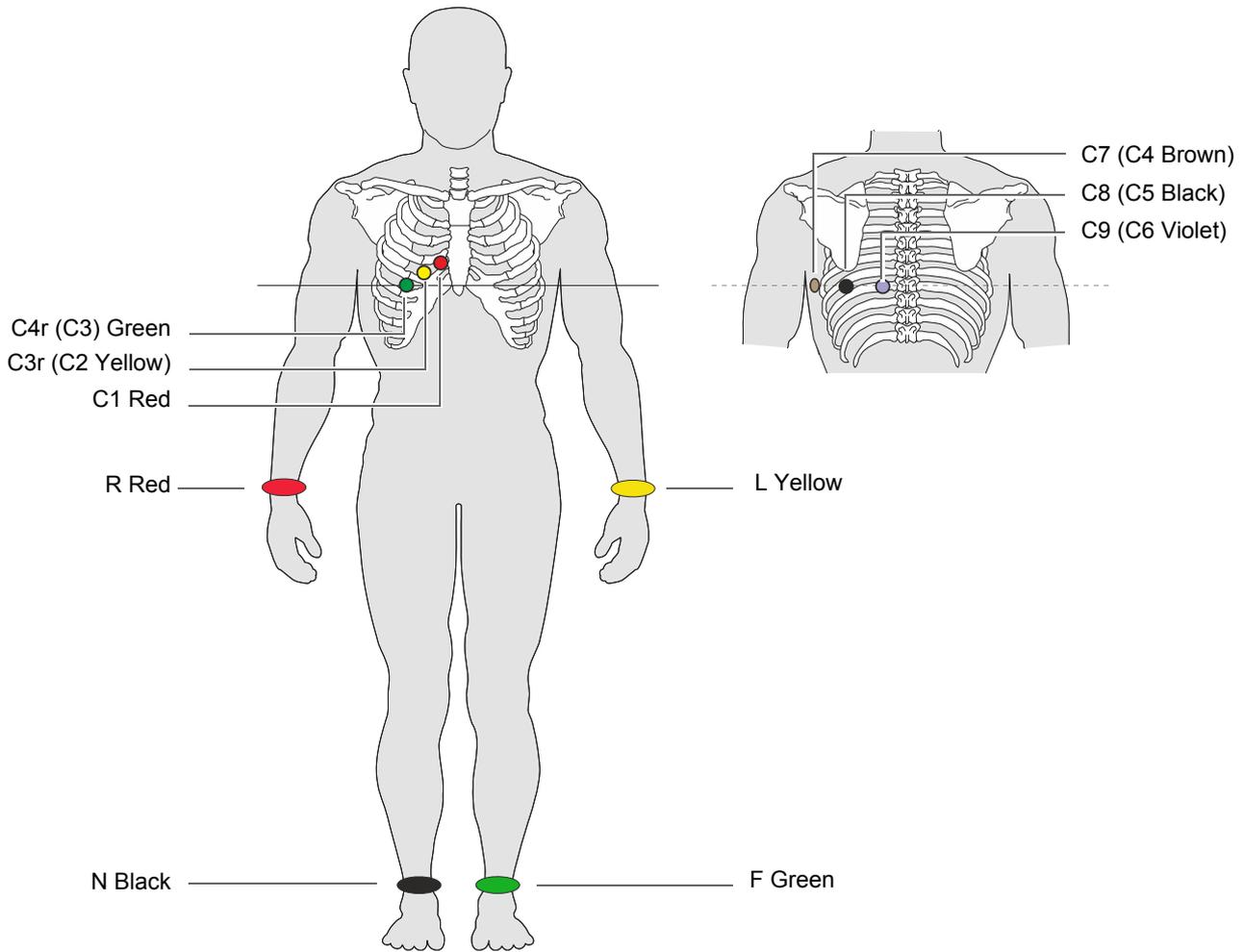
F Green

Balanced 10-wire Cable

IEC Label	AHA Label	Electrode Placement
C1 white / red	V1 brown / red	➜ Fourth intercostal space at the right sternal border.
C3r white / yellow	V3r brown / yellow	➜ Left of the mid-scapular line at the level of C3
C4r white / green	V4r brown / green	➜ Left of the mid-scapular line at the level of C4
C7 white / brown	V7 brown / blue	➜ Left posterior axillary line at the level of C4.
C8 white / black	V8 brown / orange	➜ Left posterior axillary line opposite of C4
C9 white / violet	V9 brown / violet	➜ Left posterior axillary line at the level of C4, opposite C3
L yellow	LA black	➜ Left arm
R red	RA white	➜ Right arm
F green	LL red	➜ Left foot
N black	RL green	➜ Right foot

3.7 Paediatric
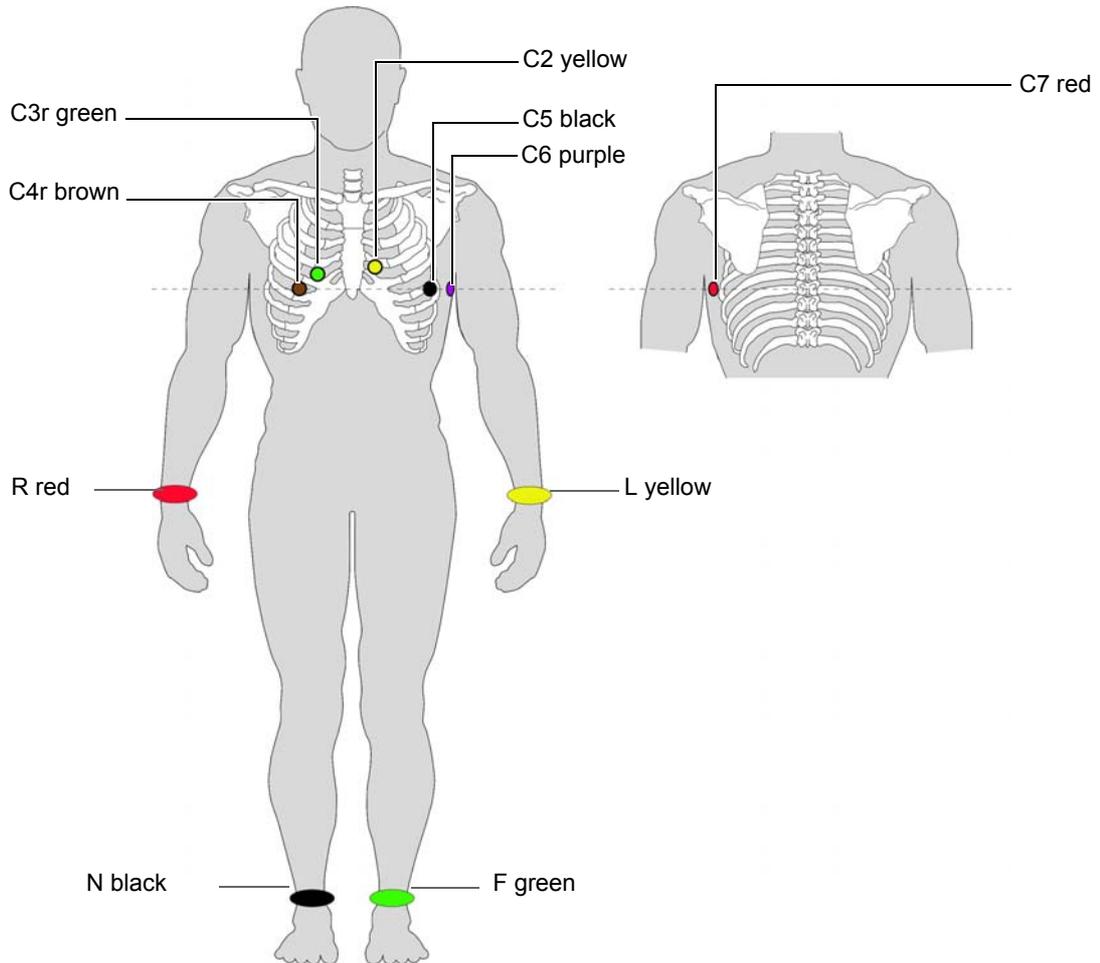
IEC label	AHA label	Electrode placement
C4r white / brown	V4r brown / blue	➜ Fifth intercostal space on the min-clavicular line.
C3r white / green	V3r brown / green	➜ Above C4r, fourth intercostal space.
C2 white / yellow	V6 brown / violet	➜ Fourth intercostal space at the left sternal border
C5 white / black	V5 brown / orange	➜ Anterior axillary line on the same horizontal level as C4r.
C6 white/violet	V6 brown / violet	➜ Mid-axillary line on the same horizontal level as C4r.
C7 (C1 white /red)	V7 (V1 brown / red)	➜ Left posterior axillary line at the level of C4r.
L yellow	LA Black	➜ Left arm
R red	RA White	➜ Right arm
F green	LL Red	➜ Left foot
N black	RL Green	➜ Right foot

3.8   Right Precordials
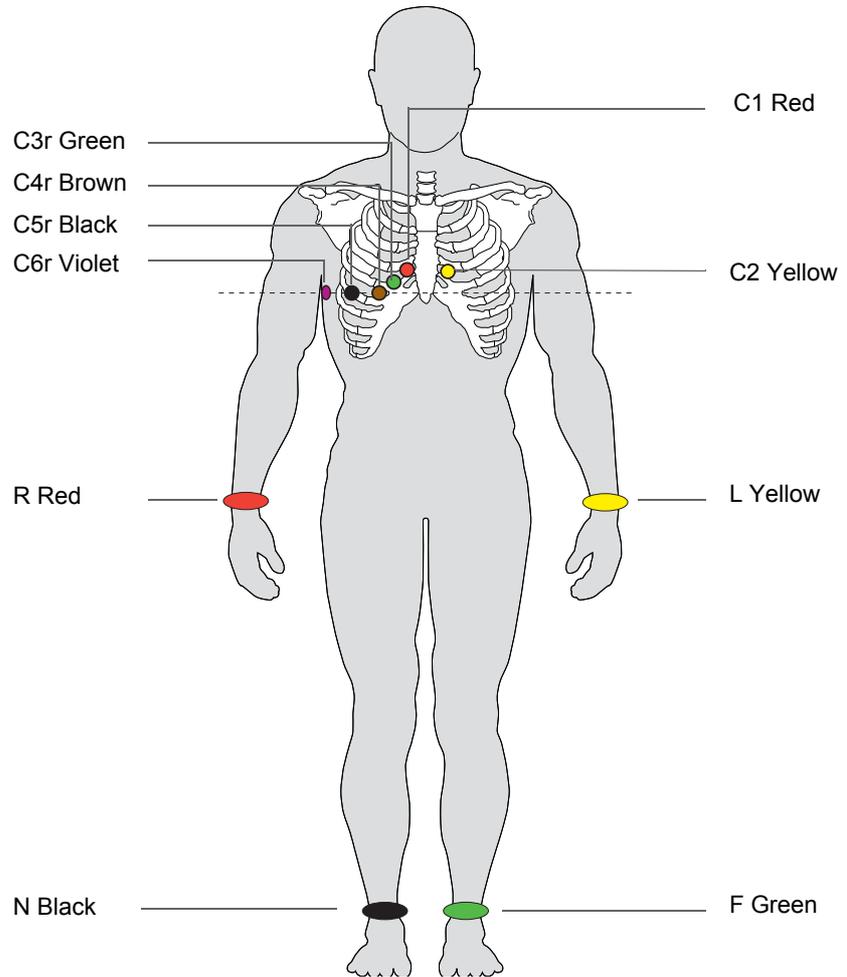
Right Precordial 10-wire Cable

IEC Label	AHA Label	Electrode Placement
C1 white / red	V1 brown / red	➜ Fourth intercostal space at the right sternal border.
C2 white / yellow	V2 brown / yellow	➜ Fourth intercostal space at the left sternal border.
C3r white / green	V3r brown / green	➜ Designated point halfway between C1 and C4r.
C4r white / brown	V4r brown / blue	➜ Fifth intercostal space in the midclavicular line.
C5r white / black	V5r brown / orange	➜ Fifth intercostal space in the anterior axillary line.
C6r white / violet	V6r brown / violet	➜ Fifth intercostal space in the mid-axillary line.
L yellow	LA black	➜ Left arm
R red	RA white	➜ Right arm
F green	LL red	➜ Left foot
N black	RL green	➜ Right foot

3.9   12 lead plus Right Precordial full (14-wire Cable)

Schiller cable designation	IEC Label	AHA Label	Electrode Placement
	C1 white / red	V1 brown / red	➜ Fourth intercostal space at the right sternal border.
	C2 white / yellow	V2 brown / yellow	➜ Fourth intercostal space at the left sternal border.
	C3 white / green	V3 brown / green	➜ Midway between sites C2 and C4.
	C4 white / brown	V4 brown / blue	➜ Mid-clavicular line in the fifth intercostal space.
	C5 white / black	V5 brown / orange	➜ Anterior axillary line on the same horizontal level as V4
	C6 white / violet	V6 brown / violet	➜ Mid-axillary line on the same horizontal level as C4.
	L yellow	LA black	➜ Left arm
	R red	RA white	➜ Right arm
	F green	LL red	➜ Left foot
	N black	RL green	➜ Right foot
A1	C6r (H) Violet	V6r (H) Violet	➜ Fifth intercostal space in the mid-axillary line.
A2	C5r (E) Yellow	V5r (E) Yellow	➜ Fifth intercostal space in the anterior axillary line.
A3	C4r (I) Red	V4r (I) Red	➜ Fifth intercostal space in the midclavicular line.
A4	C3r (M) Black	V3r (M) Black	➜ Designated point halfway between C1 and C4r.

3.10   Left Posterior

C4 Brown
C5 Black
C6 Violet

C7 (C1 Red)
C8 (C2 Yellow)
C9 (C3 Green)

R Red

L Yellow

N Black
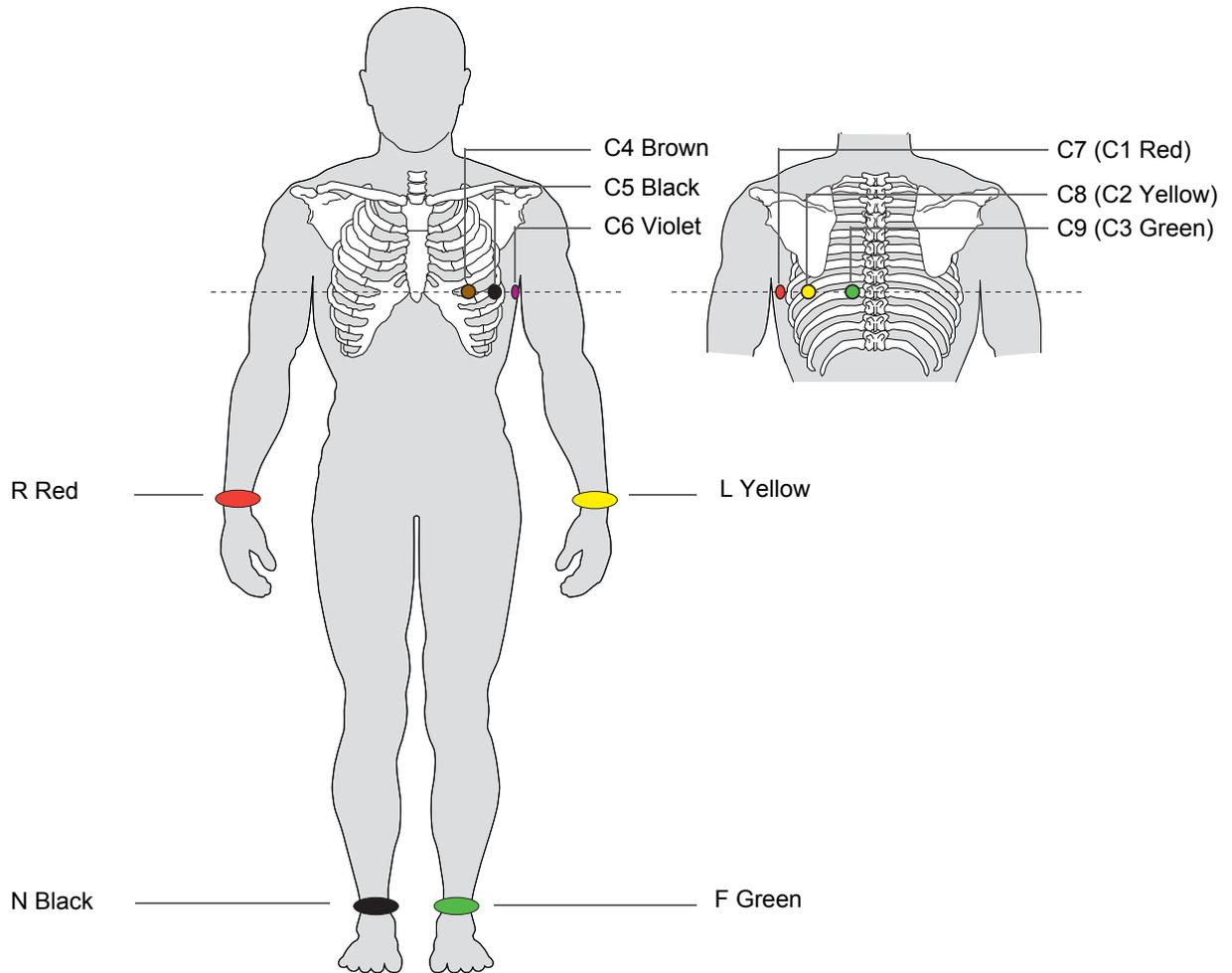
F Green

Left Posterior 10-wire Cable

IEC Label	AHA Label	Electrode Placement
C7 (C1 white /red)	V7 (V1 brown / red)	➔ Left posterior axillary line at the level of C4.
C8 (C2 white /yellow)	V8 (V2 brown / yellow)	➔ Left mid-scapular line at the level of C4.
C9 (C3 white /green)	V9 (V3 brown / green)	➔ Left paraspinal border at the level of C4.
C4 white /brown	V4 brown / blue	➔ Mid-clavicular line in the fifth intercostal space.
C5 white /black	V5 brown / orange	➔ Anterior axillary line on the same horizontal level as C4
C6 white /violet	V6 brown / violet	➔ Mid-axillary line on the same horizontal level as C4.
L yellow	LA black	➔ Left arm
R red	RA white	➔ Right arm
F green	LL red	➔ Left foot
N black	RL green	➔ Right foot

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3.11   Standard with C4r

ACC/AHA guidelines recommend examining patients suffering from a myocardial infarction with inferior ST elevation for possible RV ischemia or RV infarction; this examination should be performed with a right precordial C4r lead.
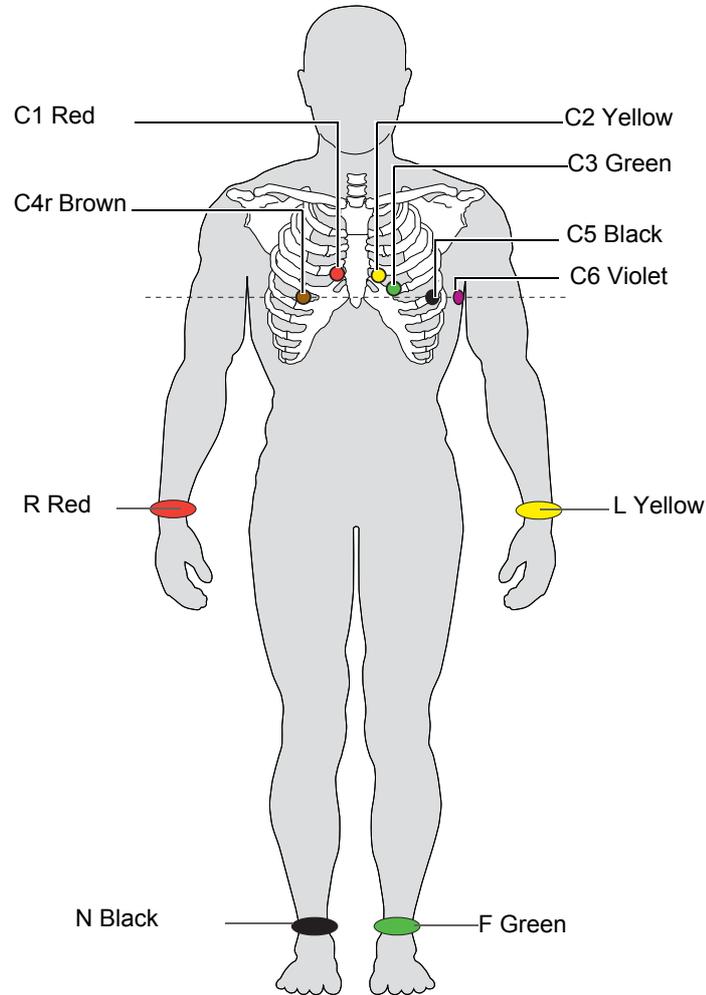
IEC Label	AHA Label		Electrode placement
C1 white / red	V1 brown / red	➜	Fourth intercostal space at the right sternal border.
C2 white / yellow	V2 brown / yellow	➜	Fourth intercostal space at the left sternal border.
C3 white / green	V3 brown / green	➜	Midway between C2 and C4.
C4r white / brown	V4 brown / blue	➜	Fifth intercostal space on the mid-clavicular line.
C5 white / black	V5 brown / orange	➜	Anterior axillary line on the same horizontal level as C4.
C6 white /violet	V6 brown / violet	➜	Mid-axillary line on the same horizontal level as C4.
L Yellow	LA Black	➜	Left arm
R Red	RA White	➜	Right arm
F Green	LL Red	➜	Left foot
N Black	RL Green	➜	Right foot

3.12   Nehb Chest (DAJ)

The Nehb leads are bipolar chest leads. They are of special interest for the diagnosis of changes in the posterior ventricle wall. Three leads are arranged in the form of a triangle, also called the "small cardiac triangle". Nehb dorsal (D) is measured between the electrode positions Nax and Nst; Nehb anterior (A) between Nap and Nst, and Nehb inferior (J) between Nap and Nax.
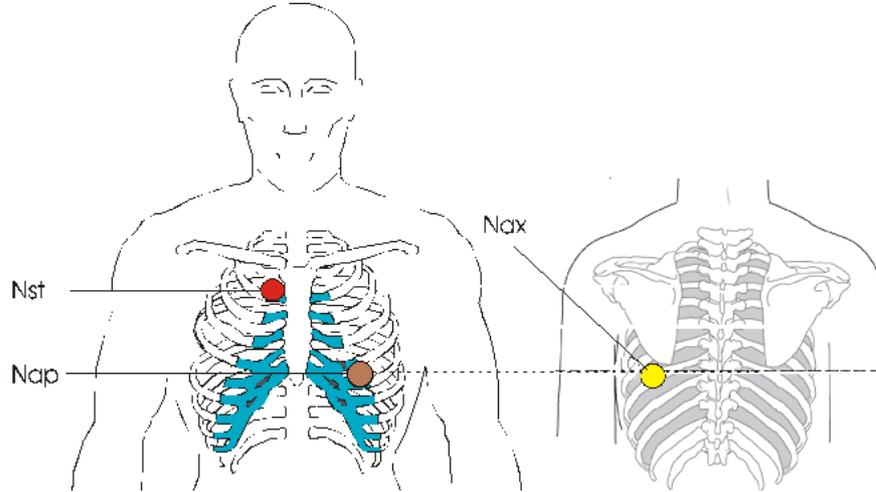
10-wire Cable

IEC Label	AHA Label	Electrode Placement
C1 white / red	V1 brown / red	➔ **Nst** - 2nd rib at the right sternal border.
C2 white / yellow	V2 brown / yellow	➔ **Nax** - The left posterior axillary line directly opposite (on the back,) from Nap.
C4 white / brown	V4 brown / blue	➔ **Nap** - 5th intercostal space mid-clavicular line

All other electrodes placed in their normal positions.

3.13   Frank Leads X, Y, Z

The orthogonal lead configuration is based on the theory of the heart as centre of a three-dimensional system of coordinates:

➜ lateral axis X

➜ longitudinal axis Y

➜ sagittal axis Z
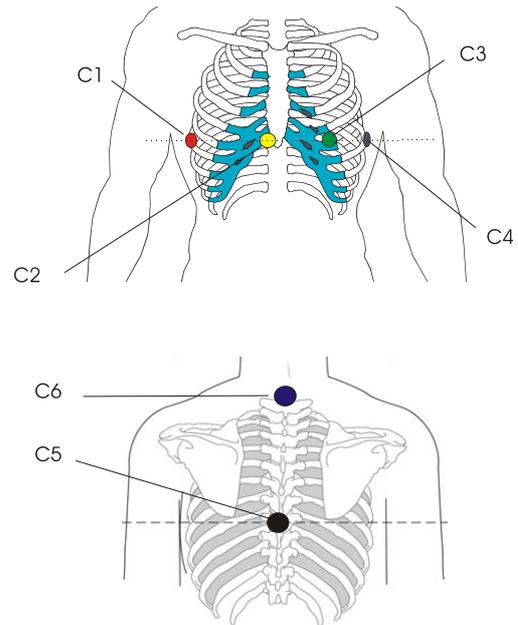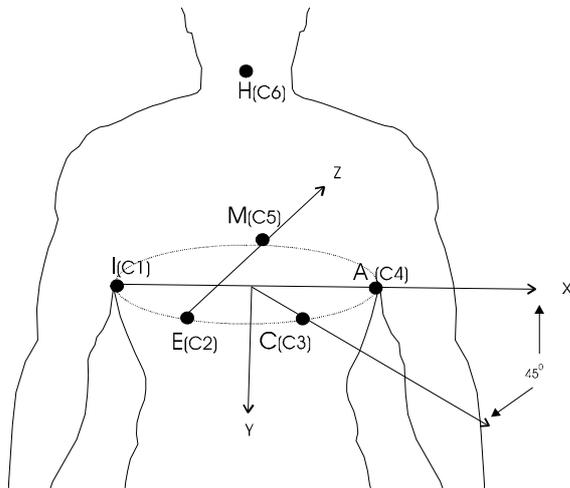
With the patient lying down, attach the electrodes on a level with the fourth intercostal space. With a patient in a seated position, attach the electrodes in the fifth intercostal space. Place all other electrodes in the normal positions.

Electrode Frank Placement 10-wire Cable

IEC Label	AHA Label	Electrode Placement
C1 white / red	V1 brown / red	➜ **I (-X) -** right midaxillary line
C2 white / yellow	V2 brown / yellow	➜ **E (-Z) -** front midline
C3 white / green	V3 brown / green	➜ **C -** between E (-Z) and A (+X)
C4 white / brown	V4 brown / blue	➜ **A (+X) -** left midaxillary line
C5 white / black	V5 brown / orange	➜ **M (+Z) -** back midline (on the back)
C6 white / violet	V6 brown / violet	➜ **H (-Y) -** neck (on the back)
L yellow	LA black	➜ Standard position - left arm
R red	RA white	➜ Standard position - right arm
F green	LL red	➜ **F (+Y) -** standard position - left foot
N black	RL green	➜ Standard position - right foot

3.14   Exercise ECG
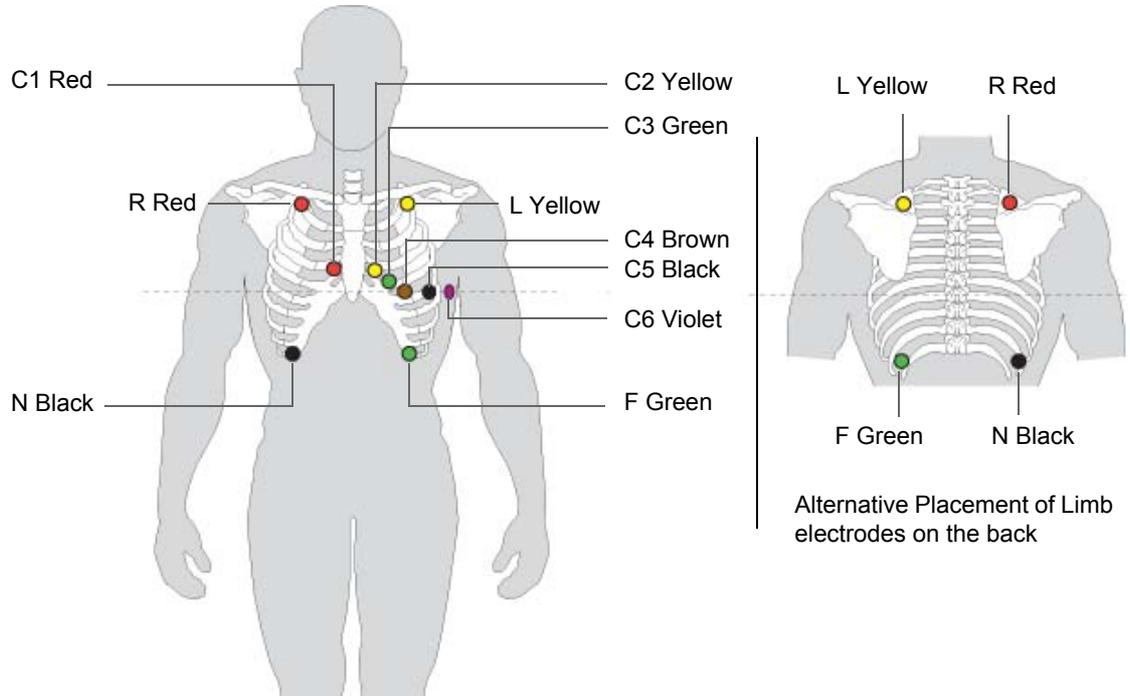
C1 Red
C2 Yellow
C3 Green
R Red
L Yellow
C4 Brown
C5 Black
C6 Violet
N Black
F Green

L Yellow   R Red
F Green   N Black

Alternative Placement of Limb electrodes on the back

IEC Label	AHA Label	Electrode Placement
C1 white / red	V1 brown / red	→ Fourth intercostal space at the right sternal border
C2 white / yellow	V2 brown / yellow	→ Fourth intercostal space at the left sternal border
C3 white / green	V3 brown / green	→ Midway between C4 and C2
C4 white / brown	V4 brown / blue	→ Mid-clavicular line in the fifth intercostal space
C5 white / black	V5 brown / orange	→ Anterior axillary line on the same horizontal level as C4
C6 white / violet	V6 brown / violet	→ Mid-axillary line on the same horizontal level as C4 and C5
L yellow	LA black	→ Slightly below left clavicle
R red	RA white	→ Slightly below the right clavicle
F green	LL red	→ Lower edge of the rib cage, or at the level of the umbilicus at the right mid-clavicular line
N black	RL green	→ Lower edge of the rib cage, or at the level of the umbilicus at the left mid-clavicular line

For exercise testing place electrodes C1 to C6 in the same positions as for the standard resting ECG detailed previously and place the R, L, F and N electrodes as follows:

- – F, on the left torso at the bottom of the rib cage
- – N, on right torso at the bottom of the rib cage
- – L and R, place either on the back above the scapular or on the front just below the clavicle.

ℹ

- • The limb electrodes can also be placed on the back as shown above.
- • The ECG recorded with the torso placement of the limb lead electrodes may differ from that recorded with the electrodes on the limbs. Affected characteristics are the Q-waves and the frontal axes, whereas ST levels are unlikely to change.

4 Recording an ECG

4.1 Entering the Recording Screen

Main menu

☑ Worklist

⊞ Recorder

Select **Recorder** from the main menu. The patient screen is displayed:

4.1.1 Patient Already Registered on an EMR System

ℹ️

NOTE: **Patient Data Query** (PDQ) is only available and the PDQ tab is only displayed when the device is networked with an EMR system.

Enter the Patient's ID and either:

- Press keyboard return, or
- Select PDQ

PDQ	SAECG	Exercise	Resting

The patient data is populated and a recording can be made.

If the patient is not found, a patient not found message is given:

Patient not found ❓

No patient found by given patient ID. Continue with this patient ID?

[Yes]   [No]
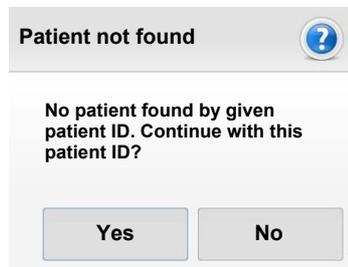
4.1.2 New Patient

Enter a patient ID that is not registered and enter patient data.

4.1.3 Emergency Resting ECG

From the Recorder screen enter the acquisition screen directly without entering patient data. The recording is taken and a random unique patient ID will be allocated - Patient details can be added before saving the ECG.

ℹ️

The patient data screen is described in the introduction (see para. 2.16, Patient Data, page 35).

4.2   Entering the Acquisition Screens

- Click **Resting** to enter the **Resting** and **Rhythm** recording screens.
- Click **Exercise** to enter the **Exercise** Recording screen.
- Click **SAECG** to enter the **Signal Averaging** screen.

PDQ	SAECG	Exercise	Resting

ℹ️ A setting is available to require that certain patient data must be entered before a recording is taken. Different data can be defined for different recording types. This is defined in system settings (see para. 13.7.6, Mandatory Fields, page 131). If a recording screen is attempted and the patient data not fully defined, the following message is given:

Patient data incomplete ❓

Patient data missing:
Patient ID
Last name
Date of birth
Start recording anyway?

[Yes]   [No]

4.3 Hookup Screen, Electrode Placement and Check

Hookup icon 👤 . (The hookup screen is available for all types of acquisition).

Electrode placement graphic is displayed in the left area of the screen and the electrode status is shown in the bottom right information field of the screen. If an error is detected the suspected reason for the poor signal quality is displayed (see next page). Reapply the electrode.

Select the lead configuration (see next page) to display the electrode placement for the specified configuration.
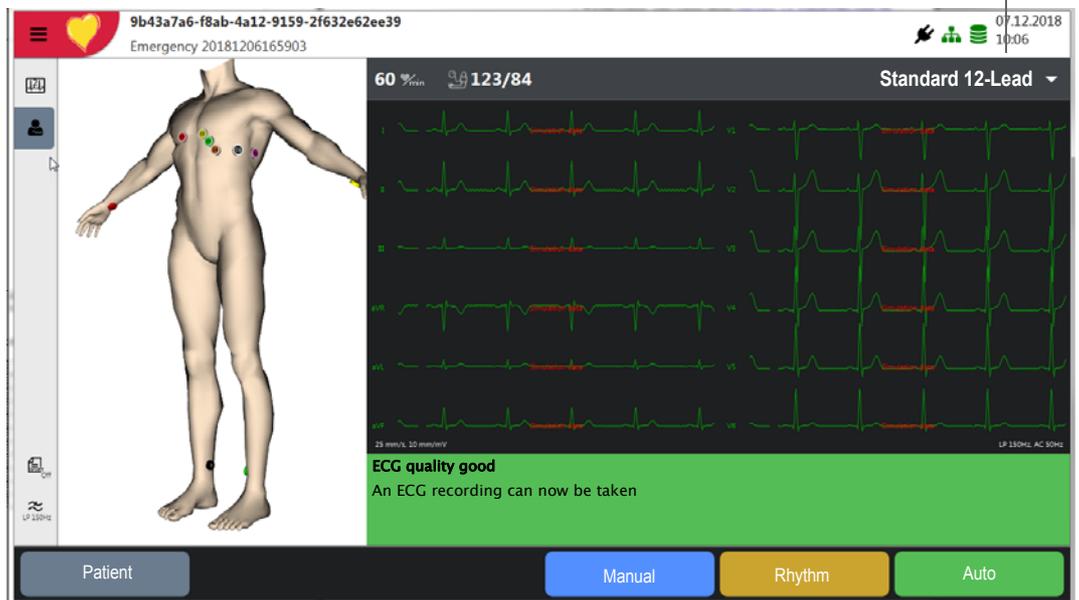
4.4 Electrode Check

In the hookup screen, the following is checked and indicated on the bottom of the screen:

- Excessive noise (signal noise too high) due to poor electrode contact or mains in-terferences (mains filter not activated)
- Electrodes reversed
- Electrodes off or high resistance
- Signal amplitude too high causing saturation of the ECG Amplifier.

If F (LL) or N is not connected or has come off, the electrode resistance cannot be measured and all leads are marked red.

Poor signal quality
Check that the electrodes are properly attached, the ECG cable is connected and the correct powerline filter is configured.

Electrode Off   C3
One or more of the electrodes are not properly connected. Please check that all electrodes are placed at the correct position.

Identified lead(s) off is/are shown

Lead reversal   C5   C6
Some of the electrodes seem to be interchanged. Please check that all electrodes are placed at the correct position.

Identified reversed leads are shown

4.4.1   Quality Indication on the ECG Trace

The signal quality is also indicated by the colour of the ECG trace as follows:

Green Trace: Good signal

Yellow Trace: Poor signal quality (excessive noise)

Red trace: Bad signal quality (or no signal), or lead reversal

Green - good signal   Red - bad signal

i

The colours given here are the default trace colours but these colours can be redefined for user preference if required in system settings (see para. 13.4.5, Preview / Review Colour, page 126)

4.4.2   Electrode Placement
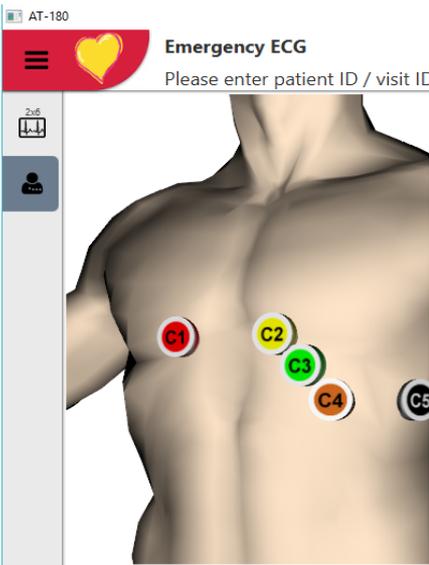
- Click anywhere in the screen to rotate and move the model for required view.
- Click on any electrode to zoom in on the electrode placement.
- When zoomed, electrode placement is given below the graphic.
- Click anywhere in the main ECG trace to zoom out again.

4.5   Standard or Cabrera Lead Sequence

Standard or Cabrera Lead Sequence is defined in system settings (see para. 13.2.1, Lead & Cable, page 119).

4.5.1   Selecting the Lead Configuration

The lead configuration is displayed and selected in the top right corner. The lead configurations available for selection are defined in system settings (see para. 13.2, ECG, page 119).
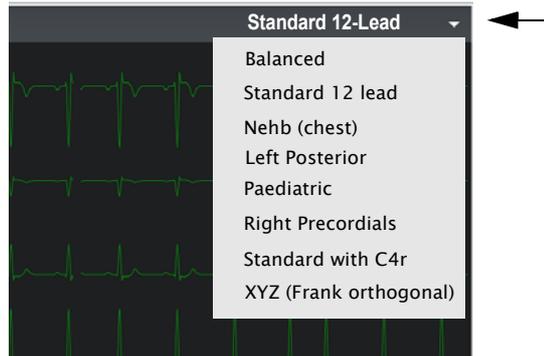
Important

- Automatic interpretation is only possible when **Standard 12 lead** is set.

4.6   Display Layout and Speed and Amplitude

Display Layout icons

Speed and Amplitude

Display Layout

Select the resting display layout icons as follows:

- 2 x 6
- 1 x 12
- 4 x 3 + 1 (Rhythm)
- 1 x 3

Note: The icons that are displayed, and their order in the icon bar are defined in systems settings (see para. , Preview / Review Layout, page 124).

Different options are given for the Resting, Exercise and SAECG.

Speed and Amplitude

The speed and amplitude of the ECG trace are displayed and set in the top left of the screen when the settings icon is clicked.
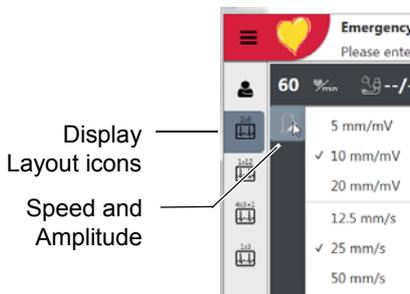
4.7   Blood Pressure
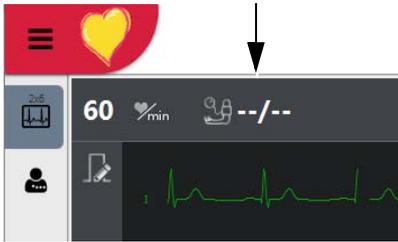
Blood pressure can be entered by clicking the Blood pressure measurement in the top left of the screen. When clicked you are prompted to enter the BP:

Enter blood pressure

Systolic: mmHg

Diastolic: mmHg

OK   Cancel

4.8   Pacemaker Detection

Toggles filter and indicates if the low pass filter applied and the cut off frequency.

Toggles ETM sport On / Off. ETM Sport is available for resting ECG only and when on, Rhythm recording is disabled. (see next page)

Toggles pacemaker detection on / off.

Pacemaker detection in all preview screens is always **OFF by default**. Pacemaker detection is activated by selecting the Pacemaker detection icon .

Detected pacemaker pulses are indicated on the ECG trace as blue vertical lines. The pacemaker lines indicate time but are not representative of amplitude nor pulse width.

Note that interpretation statements will indicate that it is a pacemaker ECG.

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4.9 Filter

The filter is designed to help reduce muscle artefact. Toggle the filter with the **Filter icon** ≈ to set the low pass cut-off frequencies to **150 Hz, 40 Hz, 25 Hz,** or **Off.** The Low pass cut-off frequency is displayed in the icon and on the screen lower right.

i

- Filter off corresponds to a cut-off frequency of 350 Hz (recommended for paediatric applications).
- The default cut-off frequencies and filter settings are defined in system settings.

4.10 ETM Sport (Option)

The ETM Sport diagnoses abnormalities in athletes in a resting ECG that otherwise would not be diagnosed. The ETM Sport icon must be clicked **before an Auto recording** is made in order to activate the algorithm.

When set, the Seattle criteria for athletes interpretation is displayed in the interpretation screen of the recording.

i

- ETM Sport is available for **Standard 12-Lead** configuration and for **Resting ECG only.** When ETM Sport is activated, the Standard 12-lead configuration is automatically set and no other configuration can be set.

4.11   Editing a Recording

Editing a recording (in the CARDIOVIT AT-180) is only possible immediately after a recording has been taken and **before the Accept icon** has been clicked (see next paragraph). After a recording has been accepted, no editing is possible in the CARDIOVIT AT-180. Recording editing functions are described in the analysis section (see para. 9, Recording Analysis, page 82).

4.12   Saving a Recording

| Accept |

Click **Accept** to save the recording.

i

- A recording can be printed after acceptance (print after save) - this is defined in system settings (see para. 13.7.9, Workflow, page 132).

4.13   Discarding a Recording

| Discard |

Click **Discard** to return to the ECG acquisition screen without saving the recording. Confirmation that the recording is not to be saved is requested.

Discard recording ?

The current recording will be discarded. Do you want to proceed?

| Yes | | No |

4.14   Viewing a Recording

A recording that is stored locally is accessed via the memory (see para. 10, Memory, page 106).

i

- Recordings can be reviewed in the memory of the device. If the settings transmit after save and delete after export are active, the recordings will not be visible in the memory. (see para. 13.7.9, Workflow, page 132).

5 Resting ECG

5.1 Auto Mode

To acquire a 10 second ECG (AUTO mode), proceed as follows:

1. Prepare the patient and connect the electrodes.
2. From the **Recording** screen:
    – If the device is networked and the patient is already registered, download the patient demographics and check/edit patient details.
    – If a new patient, enter patient details .
3. Click **Resting** icon. [Resting]
4. Check the ECG and ensure a good trace.
5. Take an **Auto recording** in one of the following ways:

    – Press the **Auto key** on the keypad

    – [Auto]   Tap the **Auto icon**

    – F6   Press **Function key F6**

6. After approximately 10 seconds the result is displayed and the recording can be reviewed and analysed.

i   If a high resistance electrode, lead off, incorrect electrode placement or high signal causing ECG amplifier saturation is detected when an auto recording is requested, a message is given to indicate this.

Poor signal quality or lead off detected   (?)

How do you want to proceed?

[**Record anyway**]   [**Cancel recording**]
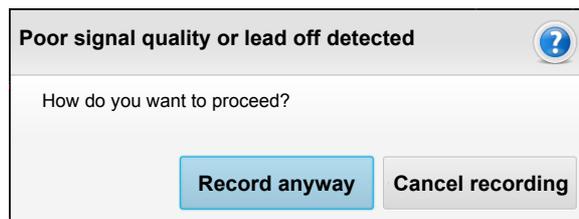
It is recommended that the hookup screen is checked before taking a recording.

5.2 Editing the Recording

Editing a recording is only possible at the end of the test before the recording is saved. A saved locally stored recording cannot be edited with the AT-180. Editing functions are detailed in the Analysis section .

5.3   Manual Mode

Manual mode provides a direct printout of the real-time ECG with full control of parameter selection. The printout provides you with the following:

• At the top the patient name, the patient ID and the data and time.
• Six (selected) or 12 leads with lead identification.
• On the lower edge, the chart speed, trace sensitivity, unit designation, software version and filters.

Start a **manual printout** in any of the following ways:

–   Press the **Manual Start key**

– Manual   Tap the **Manual Start icon**

– F4   Press **Function key F4**

5.3.1   Changing the Manual Printout

During manual printout the bottom buttons change the speed of the trace (25, or 10 mm/s) and the leads that are printed.

Change Speed   Stop Manual   Change
                      Printout   lead group

5.3.2 Stopping the Manual Printout

Stop the manual printout in any of the following ways:

– Press the **Stop key**

– Tap the **Stop icon**

– Press **Function key F4**

6 Rhythm ECG

6.1 Procedure

To take a rhythm mode recording:

1. Prepare the patient and connect the electrodes.
2. From the **Recording** screen:
    – If the device is networked and the patient is already registered, download the patient demographics and check/edit patient details.
    – If a new patient, enter patient details (see para. 4.1, Entering the Recording Screen, page 51).
3. Click **Resting** icon. Resting .
4. Check the ECG and ensure a good trace.
5. Tap **Rhythm** Rhythm or press **Function key F5** F5 .
6. Select the recording duration in the dialogue.

Rhythm Settings

Rhythm length   1 min. ▾

Show duration dialogue ✓

Start   Cancel
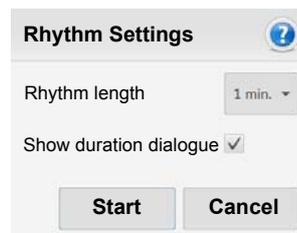
ℹ The default rhythm length, and the option to display or not display the duration dialogue before a rhythm recording is taken, is defined in system settings.

7. Commence Recording:
    – If the initial duration dialogue is displayed, click **Start** to commence recording.
    – If the initial duration dialogue is not displayed, recording commences directly.

Click to register a manual
event (see below)

Manual   real   time
printout

The recording can be cancelled in
the first 10 seconds of recording.
After this period this icon changes to
Stop and recording can be saved

- The recording will continue until the defined duration has elapsed.
- All settings, pacemaker display, blood pressure entry, filter, etc, are the same as for resting ECG (see previous pages).
- Manual events can be entered during the test (see following).
- Click **Stop** [Stop] to stop the recording before the defined time.

i In the first 10 seconds the Stop button states **Cancel** (as shown above) if you wish to cancel the recording in the initial period.

6.2 Events

6.2.1 Manual Events

To register an event click the **manual event** button ❗ .
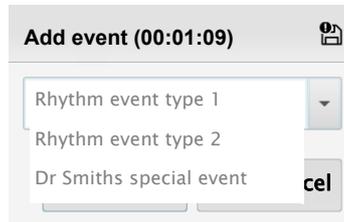
Add event (00:01:09)

Rhythm event type 1   ▾
Rhythm event type 2
Dr Smiths special event   cel

Enter any text or click the arrow to the side to select predefined events (see note), and click OK. Events will be referenced in the recording.

i   Manuel event text can be pre-entered if required, and available for selection when the arrow by the event entry is clicked. The manual event wording is defined in system settings (see para. 13.8.2, Events, page 133).

6.3 Arrhythmia (option)

When the Arrhythmia option is enabled, an extra field is given to display the Ventricular Ectopic Beat Rate (VEBR). This gives the number of ventricular ectopic beats over the last minute.

12.12.1965-smith
Smith Robert | 56 years, male

👤   60 ♥/min   🔲 --/--   VEBR 0 /min

Every time a VEBR is detected an event is registered.

6.4 Editing the Recording

Editing a recording is only possible at the end of the test before the recording is saved. A saved locally stored recording can be viewed but not edited with the AT-180. Editing functions are detailed in the Analysis section .

6.4.1 Creating a 10 s Resting ECG

A 10 s resting ECG can be created from the continuous view as follows:

Click to generate a 10 s ECG

Create resting ECG function button
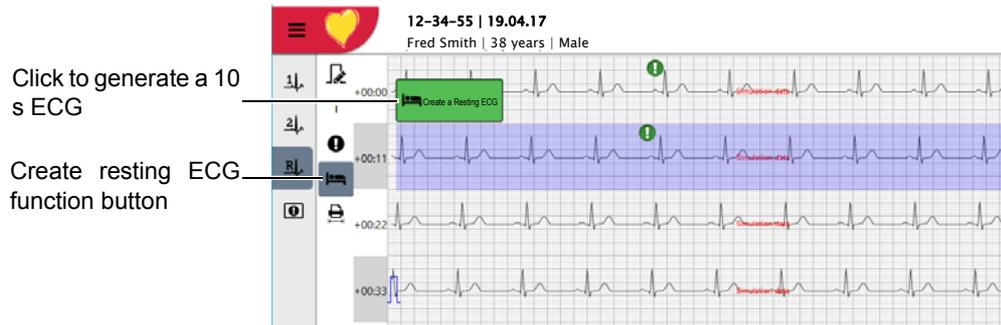
1. Click the create a resting ECG button
2. A 10 second area of the rhythm recording is highlighted blue.
3. Move the highlighted area to the rhythm section where you wish to create a 10 s resting ECG
4. Click **Create a resting ECG**.

A standard 10 s resting ECG is created and will be exported and/or displayed in the memory as defined in system settings.

6.4.2 Printing a 10 s segment

A 10 s segment can be printed from the continuous view as follows:

Click to print selected 10 s section.

Select and print a 10 s range button
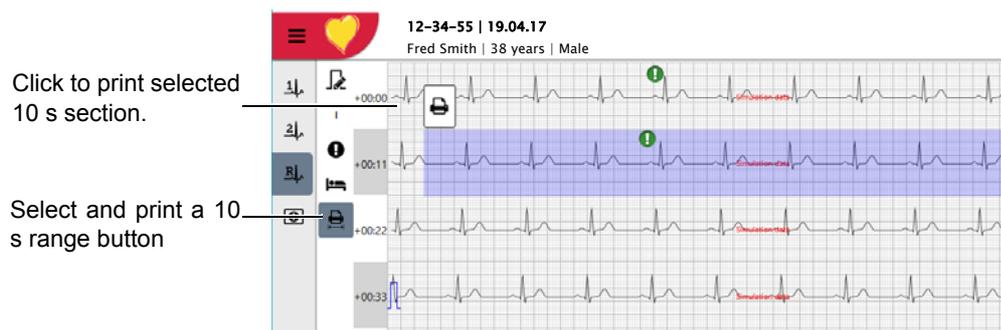
1. Click the select and print a 10 s range button.
2. A 10 second area of the rhythm recording is highlighted blue.
3. Move the highlighted area to the rhythm section where you wish to print a 10 s section.
4. Click **print icon** to obtain a printout.

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7   Signal Averaging ECG

i

Signal averaging is an option.

7.1   Introduction

The depolarisation of the atria and the ventricles, the transition from the atria to ventricles, and the ventricular repolarisation can be seen in the normal ECG recorded from the body surface. However, delayed depolarisation of very small areas in the heart, which patients may show after myocardial infarction for example, are not visible in the normal ECG taken from the body surface. To detect such ventricular potentials with an amplitude of about 10 μV, special recording techniques are required.

The signal averaging of many heart beats improves the signal-to-noise ratio in the normal ECG. The inherent noise in the signal differs from one heart beat to the other, while similar ECG signals from the heart are found with each beat. The averaging of multiple heart beats therefore minimises the noise, while the amplitudes of the ECG signals remain equal in size - hence the signal-to-noise ratio is improved. In general, a signal averaging of about 100 heart beats is required for the signal-to-noise ratio to be improved by a factor 10 (i.e. square root of 100).

To further eliminate interferences in the low frequency range, a high pass filter is used with a cut-off frequency of 25 Hz or 40 Hz. The characteristics of this high pass filter are identical to the Butterworth filter of the 4th order. In addition, low-pass filtering of 250 Hz is applied.

Only after the ECG signals have been averaged and filtered, can the ventricular delayed potentials be detected.

The ECGs analysed for ventricular delayed depolarisation are normally recorded in the X, Y, Z leads to calculate the vector magnitude.

The time interval between the beginning and the end of the QRS complex in this vector magnitude is defined as high frequency QRS duration (HF QRS duration). A prolonged HF QRS duration indicates that ventricular late depolarisation is possible. The RMS value (root mean square value) of the last 40 ms in the vector magnitude is a parameter for the area at the end of the QRS in the vector magnitude. A very small RMS (40ms) value is an indicator.

The interval starting at the point where the QRS in the vector magnitude (seen from the T wave) reaches 40 μV for the first time and ending at the end of this QRS complex is defined as LAS value (low amplitude signal value). A high LAS value is an indicator for the presence of late depolarisation.

Depending on the cut-off frequency of the high pass filter used, late depolarisation exists when at least 2 of the following criteria are satisfied (according to: J.A. Gomes, S.L. Winters, D. Steward et al: Optimal bandpass filters for time-domain analysis of the signal-averaged electrocardiogram. Am J. Cardiol. 1987; 60:1290):

40 - 250 Hz	25 - 250 Hz
HF QRS duration > 114 ms	HF QRS duration > 110 ms
RMS (40ms) < 20 µV	RMS (40ms) < 25 µV
LAS > 38 ms	LAS > 30 ms

These values do not apply for patients with bundle branch block patterns. A method of examining these patients using signal averaging is described in detail in `The signal averaged ECG in patients with bundle branch block` by T. A. Buchingham and J. P. Zbilut in `Signal averaged electro cardiography, Concepts, Methods and Applications` published by J.A. Gomes (Kluwer Academic Publishers 1993; ISBN 0-7923-2390-4). Furthermore, the evaluation of signal averaging analysis for patients with bundle branch block is described in `Bundle Branch Block and the Signal-Averaged Electrocardiogram` by J. M. Fontaine and N. El-Sherif in the book `High-Resolution Electrocardiogram` published by N. El-Sherif and G. Turitto (Futura Publishing Company 1992, ISBN 0-87993-3658). The two books give a comprehensive summary of the theory and the general application of late depolarisation analysis for different types of patients.

The signal averaging analysis carried out in the program complies with the standards summarised in ACC Policy Statement `Standards for Analysis of ventricular Late Potentials Using High-Resolution or Signal-Averaged Electro cardiography` a statement by a Task Force Committee of the European Society of Cardiology, the American Heart Association, and the American College of Cardiology, G. Breithardt, M. E. Cain, N. El-Sherif, N. C. Flowers, V. Hombach, M. Janse, M. Simson and G. Steinbeck', JACC Vol. 17, No. 5, April 1991: 999-1006.

7.1.1   Procedure Overview

The number of complexes used for the test, maximum noise and trigger point for measurement are defined in system settings .

When a test is started, the program measures the initial complexes to calculate reference averages for X, Y and Z. It assesses the best trigger point from the X, Y, Z complexes; if the user has defined the trigger point the program will use that, otherwise the program assesses the best (cleanest) trigger point and displays the reference complexes that will be used.

The user can then check the reference complexes and redefine as many times as necessary.

The user then starts the test and the program compares every complex against the reference and then accepts or rejects each complex in accordance with the criteria defined by the user. The test continues until the defined number of accepted complexes or maximum noise is reached.

The real time data is displayed during data acquisition and at the end of the test, a full analysis is given and a printout can be obtained.

7.2   Starting the Signal Averaging Analysis

1. Prepare the patient and connect the electrodes.
2. From the **Recording** screen:
   – If the device is networked and the patient is already registered, download the patient demographics.
   – If a new patient, enter patient details.
   – (see para. 2.16, Patient Data, page 35) for entering patient data.

3. Select the **SAECG** icon.

- The number of beats, correlation, maximum noise and master lead / slope are defined in system settings (see para. 13.10, Signal Average ECG, page 138) and can be checked and modified before starting the test. These can also be displayed and set from the recording screen by clicking the Config icon in the sidebar.

Select Config to set correlation, max noise, master lead, etc.

4. Tap the **Start AM** icon.
5. After a few seconds the program assesses the ECG and displays the reference complexes that will be used for the recording.
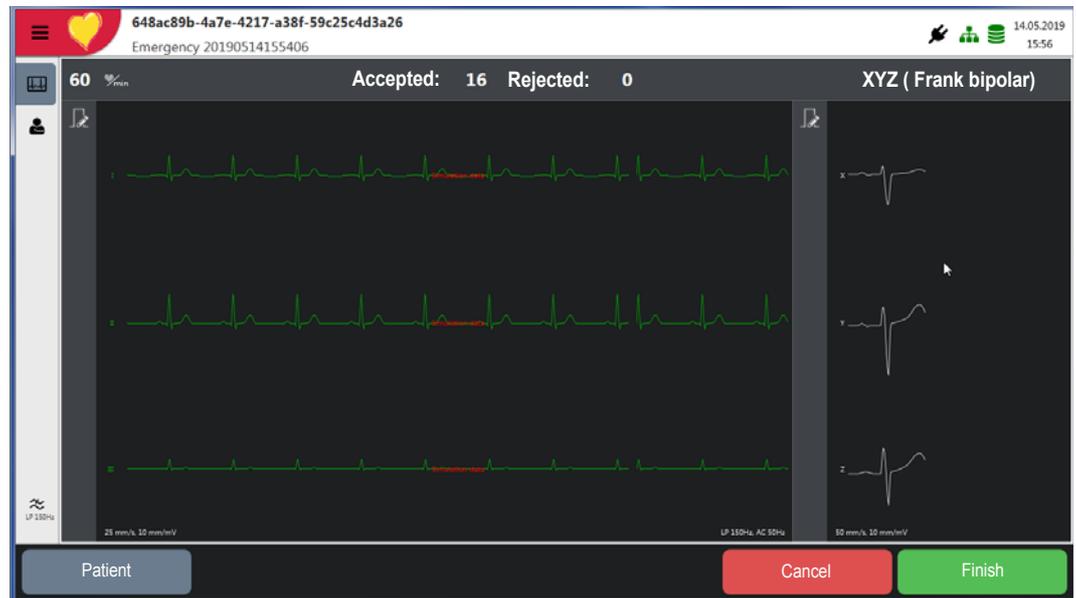
6. Check the reference complexes and retake if required by again pressing the Cancel icon.
7. The measurement commences and the number of beats accepted or rejected for analysis is displayed.
8. Data acquisition stops when the required number of accepted beats have been made or noise threshold underrun (i.e. expected high-frequency noise within the ST segment).
   – The recording can also be stopped at any time by tapping the finish icon.

7.3   Editing the Recording

Editing a recording is only possible at the end of the test before the recording is saved. A saved locally stored recording can be viewed but not edited with the AT-180. Editing functions are detailed in the Analysis section (see para. 9.3, Signal Averaging ECG, page 94).

8 Exercise ECG

8.1 Safety Notes

⚠WARNING

▲ Do not use the unit or the ergo device if the earth connection is suspect or if the mains cable is in any way damaged.

▲ A stress test may only commence when the operating instructions of the ergometer have been read and understood. This applies particularly to the safety instructions. The instructions given in this book do not override those for the ergometer.

▲ A stress test may only be started if the patient has been informed of the test procedure and the risks involved (for example of falling on the treadmill). Ensure the patient is aware of the location of the emergency stop knob and its use.

▲ Ensure that the resting ECG confirms that the patient is able to carry out an exercise ECG.

▲ Ensure a charged defibrillator is to hand when carrying out an exercise test.

▲ To avoid possible interference from the Ergometer when carrying out an exercise test, it is recommended that both the CARDIOVIT AT-180 and the Ergometer are connected to the same common ground. The potential equalisation stud, is situated on the rear of the unit. A yellow/green ground cable is supplied as an option (Article number 2.310005) to connect the unit to the hospital or building common ground.

▲ The patient connection is fully isolated. However where possible during the recording, avoid contact between the patient and patient electrodes, and other persons or conductive objects (even if these are earthed).

8.2 Treadmill Emergency Stop

▲ Ensure the subject is aware where the stop button is. At any time after the test has started, stop the treadmill by pressing the **Stop** button on the treadmill.

8.3 Settings to Check Before Taking an Exercise Test

8.3.1 Ergo Device and BP unit

Click the SCHILLER icon the top left of the screen to display the main menu and select **Settings**. Scroll through the settings and select **Exercise ECG > Ergo devices**.

– Define/ confirm the ergo device
– Define/ confirm the BP unit, if used
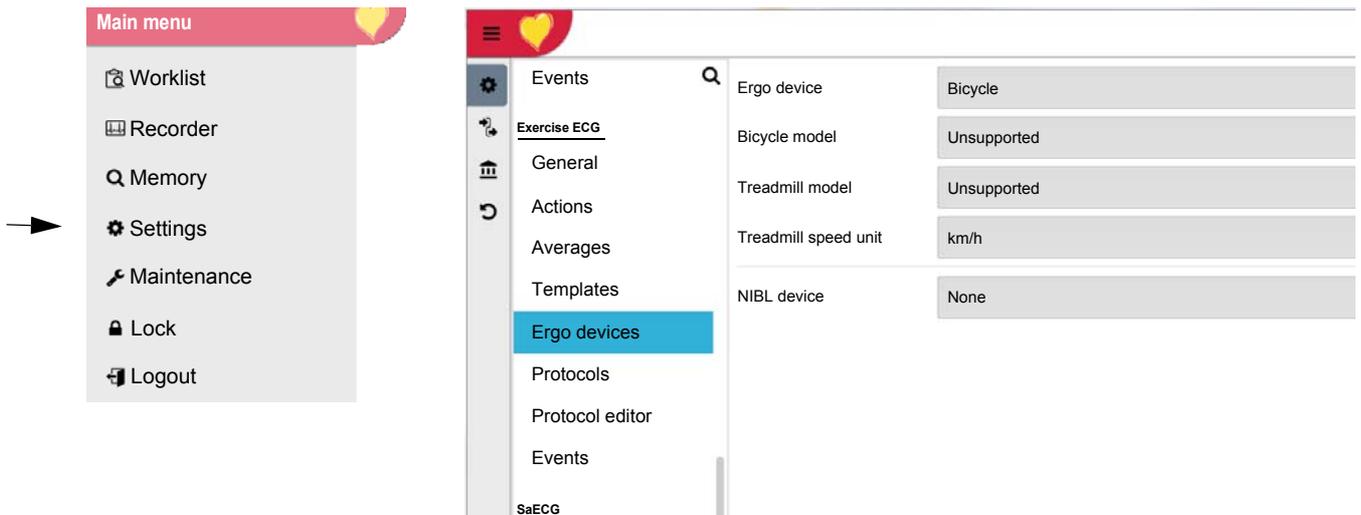
8.3.2 Protocols

Click the SCHILLER icon the top left of the screen to display the main menu and select **Settings.** Scroll through the settings and select **Exercise ECG > Protocol.** Define the protocols that can be selected for the test. Move available protocols to the **selected** column. The protocol editor is described in system settings .
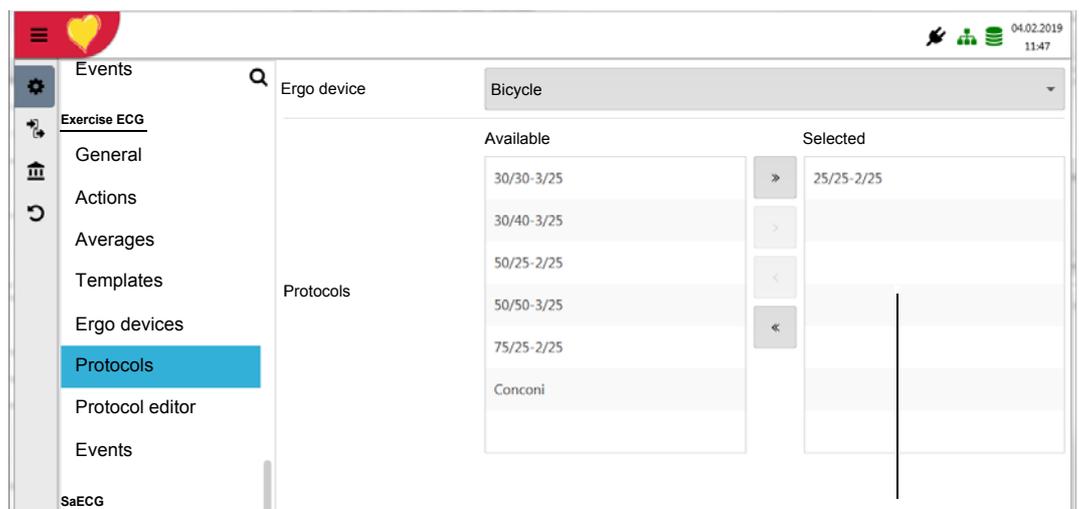
Protocols that can be selected for the test. The first is the default.

8.3.3   J-point, Target HR Calculation, ST Trend, Units

Click the SCHILLER icon the top left of the screen to display the main menu and select **Settings.** Scroll through the settings and select **Exercise ECG > General**

– Check / Define settings as required.

i Details of protocols and all exercise settings are given in the settings section.

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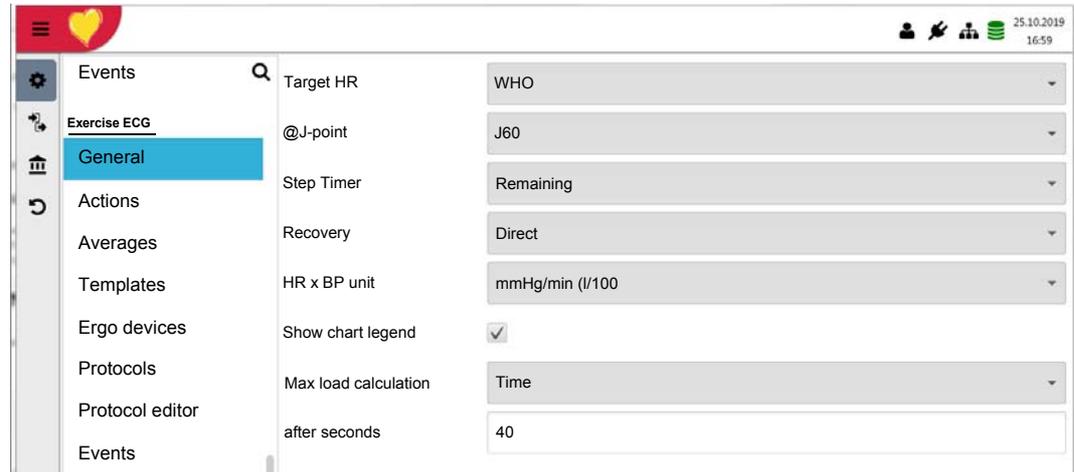
8.4   Exercise Test Procedure

1. Prepare the patient and connect the electrodes.
2. From the **Recording** screen:
   – If the device is networked and the patient is already registered, download the patient demographics and check/edit patient details.
   – If a new patient, enter patient details (see para. 4.1, Entering the Recording Screen, page 51).

3. Click Exercise ECG icon Exercise .
   – Check the ECG and ensure a good trace.

i   For correct recording and interpretation it is important that patient data is correctly entered. If full patient data has not been entered, a message is given:

Patient data incomplete ❓

Patient data missing:
Date of birth
Gender
Height
Weight
Start recording anyway?

Yes	No

4. Select the Protocol by toggling through the available protocols using the button on the bottom of the screen. (The protocols that can be selected are defined in exercise settings (see previous page).

| Patient | 25/25-2/25 | | Start |

Select protocol before the test is initiated   Initiate test

8.4.1   Starting an Exercise Test

⚠WARNING	▲ Danger of Injury. During the test the patient must be under constant observation. If a treadmill is used the emergency stop switch must be accessible at all times to both the patient and the person conducting the test.

1. Commence the test by selecting the **Start button.**
2. The warm-up phase starts according to the protocol.

i   **Note**

   •   A minimum time is set for warm-up and the Work button is greyed and cannot be activated until the minimum time has elapsed.

3. After a period of 10 seconds a reference Complex (averaged over 10 seconds) is displayed in the reference complex box in the bottom right of the screen and the average complexes of all channels with amplitude and slope, are displayed in the acquisition screen (if active).

Work to commence test

4. Click the **Work button** to commence the test according to the protocol.

i   **Note**

   •   The recording is cancelled if pre/warm-up step exceeds 120 minutes.
   •   The recovery stage is entered automatically if the work stage exceeds 120 minutes.
   •   The recording is stopped if the recovery stage exceeds 120 minutes.

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8.5   During the Test

The following is an example of the screen during an exercise ECG when using a bicycle ergometer.

View settings
(see note)

Set trend graph scale

Trend:
• Load
• Heart rate
• Blood Pressure
• METs

Trend:
• ST Amplitude
• ST Slope

Individual lead ST Amplitude

Load applied. Click the arrows to decrease / Increase load

Register an event

Enter RPE value

Enter lactate event (see note)

BP measurements on/off

Protocol identification. A star indicates that the protocol has been modified

Lead and J+x point. Click to redefine

Test Control Buttons

ℹ

Note

• Event, RPE and lactate icons in the side bar are set for user preference in system settings (see para. 13.9, Exercise ECG, page 133).

8.5.1   Test Control Buttons

The test control button on the bottom of the screen are as follows:

Pause (treadmill only)

Pause current stage. The button changes to **Resume** and the step counter is stopped (but total work counter continues) until the stage is resumed. During this time the treadmill speed drops to 0.

Hold

Hold current stage. The button changes to **Resume** and the step counter is stopped (but total work counter continues) until the stage is resumed. During this time the current load / speed settings are held.

Next

Go to next stage.

Init Recovery / Recovery (depends on setting)

Initiates the recovery phase and the button changes to End. The recovery stage is held for as long as defined in the protocol or until End button is pressed.

8.5.2   Information and Settings Panel

Heart Rate

- Current heart rate. The green bar after the heart rate shows the target heart rate and the percentage that the current heart rate is of the target heart rate.
- If the target is exceeded, the Heart rate changes from green to red to indicate that the target is exceeded.
- (the formula used to define the target heart rate is defined in system settings).
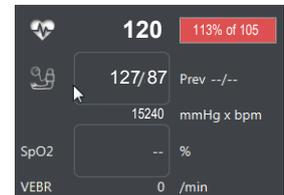
Blood Pressure

Last entered/recorded blood pressure measurement (systolic/diastolic). The value is displayed until a new value is entered /measurement taken, or until a new exercise stage is entered. The previous BP is given beside the current value.

The BP can be entered manually by selecting the BP field or automatically acquired by a blood pressure device.

mmHg x bmp

The (last) BP measurement taken in the stage x the heart rate.

Lactate

Select to enter the respective measurement and description.

SpO$_2$

The SpO$_2$ measurement received from a connected device /entered manually.

VEBR

Ventricular ectopic beat rate (see para. 8.5.6, Arrhythmia (option), page 79).

Current Load and percentage of target

- Current load in Watts (bicycle) or speed and elevation (treadmill).
- Percentage of the current load/METS to the target load/METS (must have patient height, weight and birth date entered).
- The load in Watts or Mets according to the user configuration and ergo device type.
- The load can be increased / decreased with the arrows to the side of the value.

Protocol information
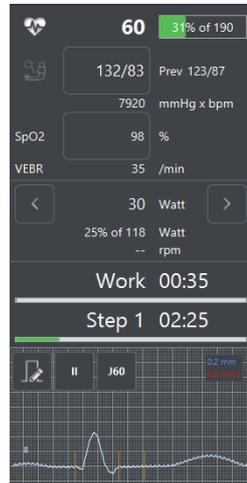
Current BP and previous BP (see next page)

Current SpO$_2$ (see next page)

Accumulative time that the patient has been under load (from the start of the test)

Current step and the time in that stage. Note: The time can be ascending or descending and this is set in exercise settings (see para. 13.9.1, General, page 133).

Reference Complexes

A zoom reference complex is at the bottom of right of the screen.

The reference complex for all leads can also be displayed at the end of the ECG real time display. This is enabled / disables in system settings.

- The reference complexes are defined in the warm-up phase.
- The reference complex lead and the J+x point can be changed at any time (see ST Measurement previous page).
- The ST amplitude and slope measurements are shown at the top right of the zoom complex.
- The vertical lines on the reference complexes show measurement points are as follows:
  - The first line on the left gives the beginning of the QRS complex.
  - The second vertical line gives the end of the QRS complex (J-point)
  - The third vertical red line gives the J+x point.

ST measurement

The current ST measurement. The J+x point is shown in the top left of the reference screen. The J+x point can be changed at any time by clicking the J+x point indicator.

Current ST measurement and slope

Define Measuring J+x point

Define Lead
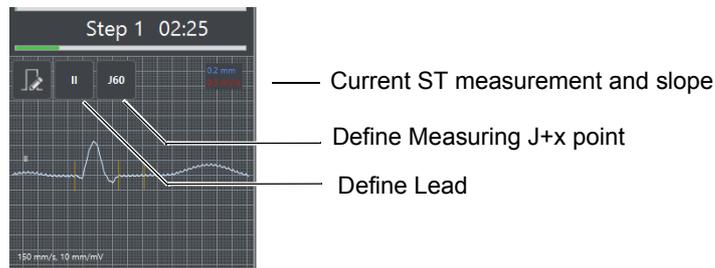
The Lead on which the ST measurement is displayed can be selected next to the ST measurement display. When **Auto** is selected, the lead with the lowest ST amplitude is selected, that is, the lead with the largest ST (depression) - positive or negative from any of the following leads from leads I, II, III, aVF, V2, V3, V4, V5, V6.

8.5.3   Trend Graphs

The trend graphs at the top of the screen give the following information:

• HR, BP, METS and Load Trend over the test.
• ST Amplitude and slope
• Reference ST amplitude / actual ST amplitude of every lead

8.5.4   Blood Pressure

BP can be taken manually or automatically at any time during the test. The BP can be entered manually by selecting the BP field, or taken automatically by a BP device attached to the unit. If an approved BP device is attached to the unit, the measurement can be initiated by clicking the BP field.

When BP measurements are defined in the protocol, the BP is triggered from an attached device or the BP field turns orange for the manual entry, 50 seconds before the end of the stage.

The automatic BP can be turned off at any time during the test by selecting BP on/off icon in the side panel .

8.5.5   SpO$_2$

SpO$_2$ measurements are either entered manually or taken by an SpO$_2$ device attached to the unit or incorporated in an BP unit (for example the SCHILLER BP-200 with SpO$_2$ option). SpO2 measurements are entered manually by clicking on the SpO2 field.

SCHILLER
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8.5.6   Arrhythmia (option)

When the Arrhythmia option is enabled, an extra field is given to display the Ventricular Ectopic Beat Rate (VEBR). This gives the number of ventricular ectopic beats over the last minute.
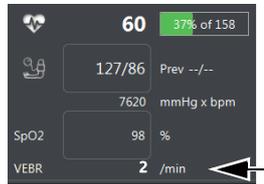
Every time a VEBR is detected an event is registered .

8.5.7   Treadmill (Speed and Elevation) Control
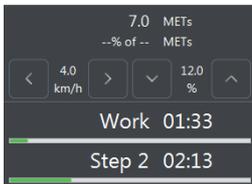
Treadmill elevation and speed can be manually increased or decreased from the current values at any time in the test or stage in the protocol. Click the arrows up/down to increase/decrease elevation, or left right to decrease/increase speed

8.5.8   Bicycle (Load) Control

Bicycle load can be manually increased or decreased from the current values at any time in the test in the same manner as for a treadmill. Click the left/right keys to decrease/increase the load.

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If a protocol is manually modified, the name of the protocol has a asterisk **(*)** after the name to indicate that the current test protocol has been modified.

Using the Keyboard to Increase / Decrease Bicycle Load, or Increase / Decrease Treadmill Speed/Elevation

The arrow keys on the keyboard can also be used to change the load or speed / elevation as follows:

Key	Function
Up key	Increase load or elevation
Down key	Decrease load or elevation
Left key	Reduce treadmill speed
Right key	Increase treadmill speed

8.5.9   Lactate and RPE Entry

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The Lactate, RPE and Event icons are given in the side bar. These icons must be set for view in system settings (see para. 13.9.1, General, page 133).

Lactate

This defines a lactate event for later entry of lactate during review (see para. 9.4.2, Editing the Results in the Step Table, page 99)

RPE

Enter RPE (1-20)

RPE | |

| Ok | Cancel |

Rating of perceived exertion (RPE is an subjective indication or patient exertion). The entered RPE is shown on the final report. Select **RPE** icon from the side bar.

8.5.10   Events

Add event (00:01:09

Rhythm event type 1   ▼
Rhythm event type 2
Dr Smiths special event

...cel
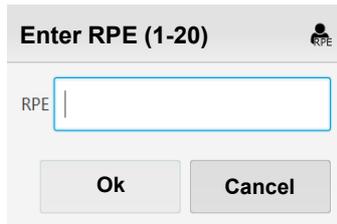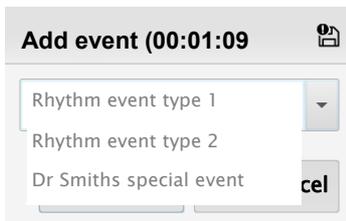
To register a manual event click the **manual event** button in the side bar.

Enter any text or click the arrow to the side to select predefined events (see note), and click OK. Events will be referenced in the recording

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Manuel event text can be pre-defined and available for selection when the arrow by the event entry is clicked. The manual event wording is defined in system settings (see para. 13.9.8, Events, page 137).

8.6   Ending the Test

Two options are possible to end the test, dependent on exercise settings, as follows:

• The recovery stage is entered directly.
• Recovery is initiated with the current exercise stage completed before entering the recovery stage.

The settings for these two options are set in system settings. (see para. 13.9.1, General, page 133)

The options are as follows:

Recovery   **Directly enter the Recovery stage -** control button displays **Recovery**

The recovery stage is entered directly and a load applied, or treadmill speed and elevation set, according to the recovery stage of the protocol. The protocol stage states Recovery and the total recovery time shown in the information box. The button designation changes to **End.** The recovery phase is held for as long as set in the protocol or until End is pressed.

Init. Recovery   **Finish current stage before entering recovery stage -** control button displays **Init Recovery**

Tap **Init Recovery button** to enter the recovery stage. The current exercise stage is completed before the recovery stage is entered. The button changes to **Recovery** to directly enter the Recovery stage. At the end of the stage the recovery stage is entered, the recovery stage time is displayed and test ended as described above.

Work 05:59
Recovery 02:47
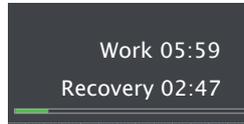
The ergometer reverts to the defined recovery load or speed as defined in the protocol. ECG recording continues during the recovery phase. The recovery phase is held for as long as set in the protocol or until End is pressed.

8.6.1 Writing a Report During the Recovery Phase

When set in the layout settings for display in Preview (see para. 13.4, Layout, page 124), the report screen is displayed and becomes 'active' during the recovery stage.

End of test information (see para. 9.4, Exercise ECG, page 96).

The report can be written or a template can be entered here

Select pre-defined statements from the pull down menus. The statements will appear in the interpretation section (see para. 9.1.7, Interpretation, page 85)
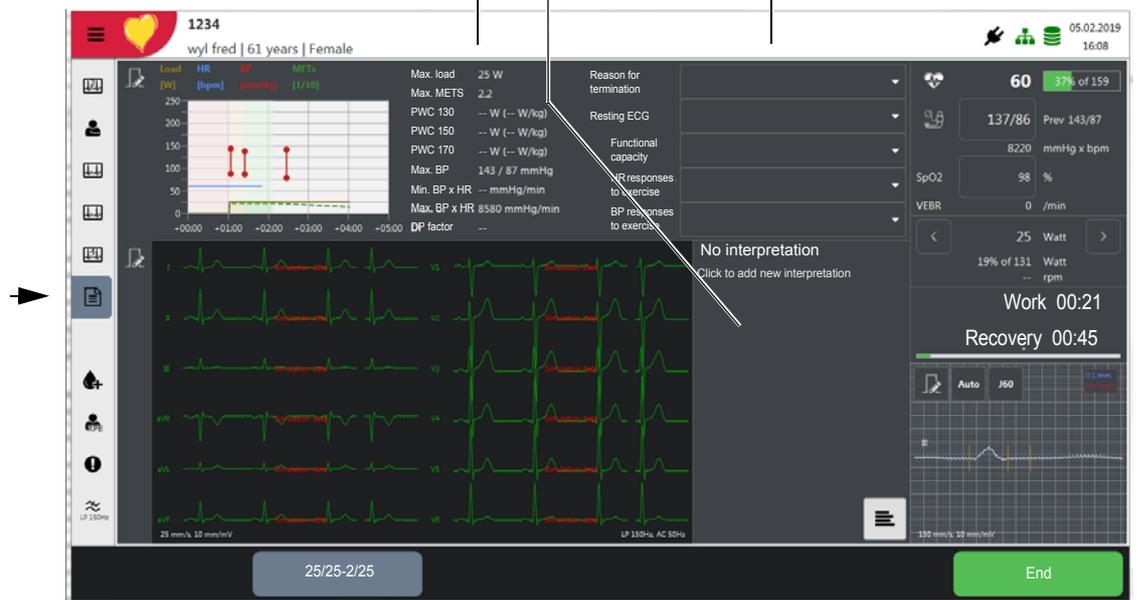
8.7 Editing the Recording

Editing a recording is only possible at the end of the test before the recording is accepted. A locally stored recording can be viewed but not edited with the AT-180. Editing functions are detailed in the Analysis section (see para. 9.4, Exercise ECG, page 96).

9 Recording Analysis

Recordings are displayed and can be edited on the CARDIOVIT AT-180 after a recording has been made.

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Notes:

- **After editing, the ECG must be accepted to save the recording.**
- Recordings can only be edited with the CARDIOVIT AT-180 immediately after a recording has been taken and before a recording has been accepted (saved). Once saved, recordings can only be edited in SEMA.
- Recordings that are stored locally in the memory can be viewed but not edited (see para. 10, Memory, page 106). The memory function only displays recordings that are saved locally and recordings that have been exported may not be available for view in the CARDIOVIT AT-180 dependent on settings.

9.1 Resting ECG Recordings

9.1.1 Data Views and Functions

Click a view / function icon to display and select:

Icon	Name	Description
1	Rhythm 1	This view shows all leads over the entire recording.
2	Rhythm 2	This view displays all leads in two columns contiguously.
A	Averages	The averaged leads with markers. The rhythm strips of two selected leads over the entire recording are also displayed.
⊞	Measurements	Table of amplitude and timing measurements for all channels.
⌕	Re-measurement	In this screen a zoomed view of a selected lead is given and measuring points and heart rate can be edited. A new interpretation can be generated after editing if the ETM option is active.
SPORT	ETM Sport	ETM Sport results (Seattle Criteria) (available if the ETM option is active).
S	Sequential	This view displays the recording in four columns of 2.5 second segments contiguously. The rhythm strips of two selected leads over the entire recording are also displayed.
XYZ	Vector	Vector view and measurement of 12-lead standard ECG (option). License not required when leads (Frank, standard + X, Y, Z) have been captured on the original recording.
LP 150Hz	Filter	Filter on/off and cut-off frequency.

i   The view and function icons are user set - Settings > Layout > Review (see para. 13.4, Layout, page 124).

9.1.2   ECG Filter
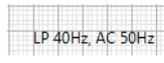
The filter is designed to help reduce muscle artefact. The cut-off frequencies and filter settings are defined in system settings.

Click the **LP Filter** icon ≈ to toggle the filter between the defined frequencies.

When the filter is enabled the icon is highlighted and indicated in the bottom of the screen.

▲   When the filter is active, possible morphological signal distortion can occur.

9.1.3   Amplitude and Speed

The amplitude and speed of the ECG trace is adjusted with the icon in the top left of the screen.

The amplitude and speed of a waveform can also be changed using the mouse if connected.

- Position the cursor in any ECG curve area and rotate the mouse wheel to increase / decrease the **trace amplitude**.
- Press the **Alt key** and rotate the mouse wheel to increase / decrease the **trace speed**.

9.1.4   Changing the Rhythm leads (Rhythm and Sequential Views)

Click the Lead designation to select the rhythm lead displayed.

Note that amplitude, speed and lead change apply only to the review on the screen, not to the printout.

9.1.5   Measurement Table

Select **Measurements** ⊞ to display averaged ECG measurements in tabular form.

When a measurement point is edited (see following), the values automatically change in the measurement table (and the measurement makers in the average view).

9.1.6   Re-Measurement - Changing the Global Measurement Points

Re-measurement is an option.

Select **Re-measurement** 📏 (in the side bar or on the HR and measurements box)

to display the re-measurement tool. The highlighted lead is selected in the top left of the screen. All other leads are greyed for reference.

Highlighted lead and selection. P and T waves can be displayed separately. When measurements are displayed, the P and T interval cannot be changed.

Manually adjusted values **are indicated blue**
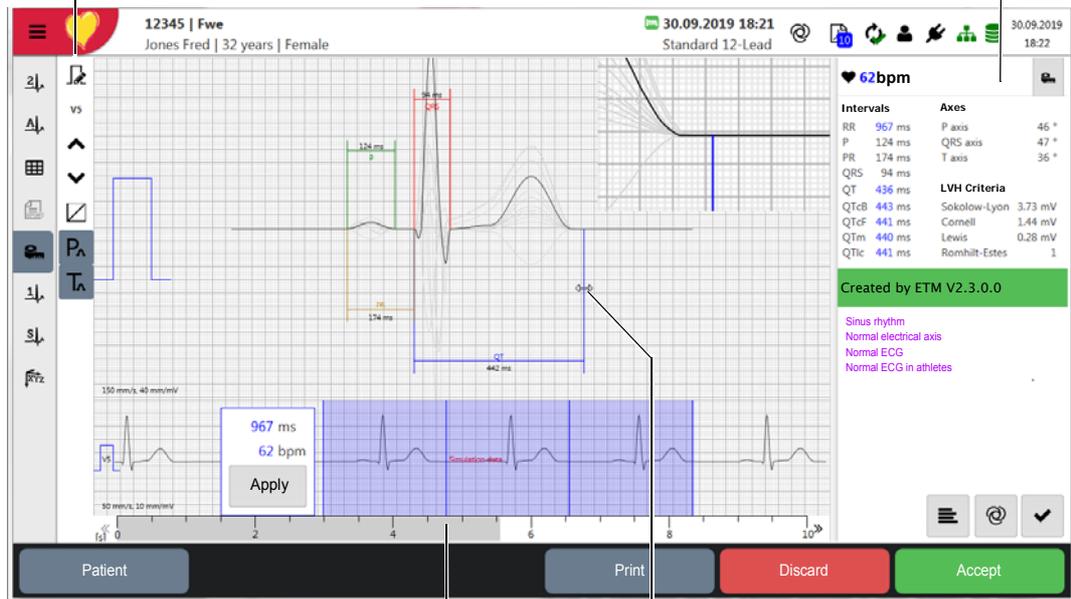
Click and move to modify interval.

Click on a measurement pointer to edit. A zoom view is shown top right and recalculated intervals are displayed.

Click on any of the measurement markers. This displays an enlarged view of the selected area. Move the marker to redefine the measurement point. When a measurement point is edited, all calculated measurements (in the measurement box) are automatically recalculated. The values automatically change in the measurement table and the measurement makers in the average view as well.

ℹ️   Because changing the global measurement points can affect the interpretation, when the measurement point is moved you are prompted to reinterpret the recording (if ETM option is active). The auto symbol ⓐ appears in the top right of the screen indicating that reinterpretation should be considered and the following message is given detailing the editing changes that have been made to the recording.

> **Reinterpretation recommended**
> Relevant data has changed:
> · Measurements

9.1.7   Interpretation

The interpretation is displayed below the heart rate and measurements. If the interpretation has been generated by the interpretation program and has not been edited /validated, the ETM version is stated. After editing/validation, the user is stated, for example:

- Created by ETM V2 3.0.0
- Created by Dr. Smith
- Validated by Dr. Smith

Creation/Validation/user - click for more details (interpretation date, institutes, etc.

Manually entered interpretation black. Interpretation or measurements entered from templates shown coloured bold.

Validation: Click the tick box ✔ to validate the interpretation. When an interpretation has been validated, no further changes can be made. Validation can only be made by a defined user (see note below)

Trigger an auto (ETM) re-interpretation (not possible after an interpretation has been validated).

Editing: Enter text as required. Enter a character(s) and click the interpretation templates and acronyms icon ☰ (or press **CTRL > space bar)** to display interpretation templates and acronyms beginning with the entered characters. Position the cursor with no text and click the icon to display all templates and acronyms.
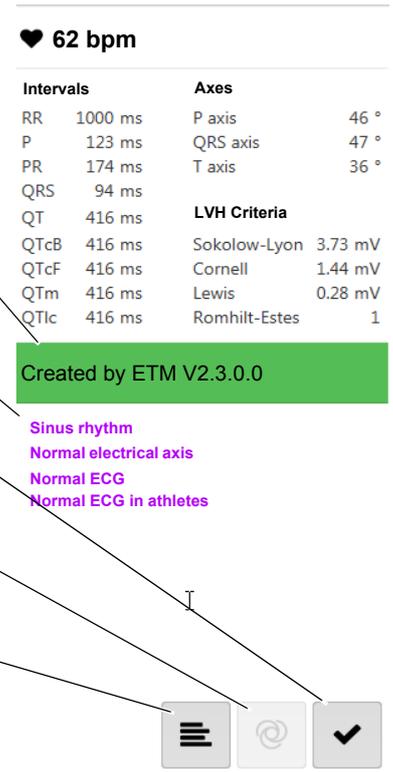
♥ **62 bpm**

Intervals		Axes	
RR	1000 ms	P axis	46 °
P	123 ms	QRS axis	47 °
PR	174 ms	T axis	36 °
QRS	94 ms		
QT	416 ms	**LVH Criteria**	
QTcB	416 ms	Sokolow-Lyon	3.73 mV
QTcF	416 ms	Cornell	1.44 mV
QTm	416 ms	Lewis	0.28 mV
QTlc	416 ms	Romhilt-Estes	1

Created by ETM V2.3.0.0

Sinus rhythm
Normal electrical axis
Normal ECG
Normal ECG in athletes

Interpretation Categories

There are three categories of interpretation indicated by colour as follows:

Created by ETM V2.2.0.1
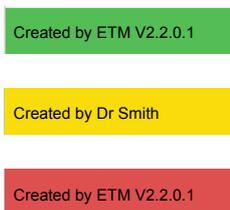
- Green - category normal

Created by Dr Smith

- Yellow - category borderline

Created by ETM V2.2.0.1

- Red - category abnormal

ℹ️ **Note**: The validation button is only visible if access control is set to either Local or Schiller Server AND the logged in user has the validation privilege assigned. If either of these are not true the validation button is not displayed.

9.1.8   ETM Sport Option

(Seattle Criteria Interpretation for Athletes)

ℹ️ The **ETM Sport** icon must have been clicked in the recording data screen to display the ETM Sport interpretation in the interpretation screen.

When the ETM sport was selected in the original recording, an extra line is given in the interpretation screen that states one of the following:

- Normal ECG in athletes
- Borderline ECG in athletes
- Abnormal ECG in athletes

Editing ETM Sport Diagnosis and Displaying Diagnosis Criteria

When the ETM Sport icon is clicked in the side panel 🔲, the Seattle criteria are shown:

ETM Sport diagnosis.

Checking a criteria activates that observation and changes the interpretation (see next page).

Hovering over a criterion will give the measurement parameters used to assess the criterion.

The ETM interpretation is shown in the interpretation and is colour coded in the ETM screen. The interpretation changes when any criteria is edited:

Normal ECG in athletes (statement highlighted Green)

None of the criteria are observed.

Borderline ECG in athletes (statement and criterion highlighted yellow)

No further evaluation required in asymptomatic athletes with no family history of inherited cardiac disease or SCD.

Abnormal ECG in athletes (statement and criterion/criteria highlighted red)

These ECG findings are unrelated to regular training or expected physiological adaptation to exercise, may suggest the presence of pathological cardiovascular disease, and require further diagnostic evaluation.

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The ETM sport interpretation will change as the ETM sport criteria are edited. The ETM sport interpretation will also change if the global measurement points are changed (and reinterpretation is triggered (see previous page).

Interpretation Decision Tree

International consensus standards for ECG interpretation in athletes, Drezner JA, et al. Br J Sports Med 2017;1:l-28. doi:10.1136/bjsports-2016-09733.

Normal ECG
- Increased QRS voltage for LVH or RVH
- Incomplete RBBB
- Early repolarisation/ST segment elevation
- ST elevation followed by T wave inversion V1-V4 in black athletes
- T wave inversion V1-V3 $\leq$ age 16 years old
- Sinus bradycardia or arrhythmia
- Ectopic atrial or junctional rhythm
- I*AV block
- Mobitz Type I 2*AV block

Borderline ECG
- Left axis deviation
- Left atrial enlargement
- Right axis deviation
- Right atrial enlargement
- Complete RBBB

In isolation ($\leq$ 1) $\geq$ 2

Abnormal ECG
- T wave inversion
- ST segment depression
- Pathologic Q waves
- Incomplete LBBB
- QRS $\geq$140 ms duration
- Epsilon wave (not detected)
- Ventricular pre-excitation
- Prolonged QT interval
- Brugada Type 1 pattern
- Profound sinus bradycardia < 30bpm
- PR interval $\geq$ 400 ms
- Mobitz Type II 2*AV block
- 3*AV block
- $\geq$ 2 PVCs
- Atrial tachyarrhythmias
- Ventricular arrhythmias

Normal
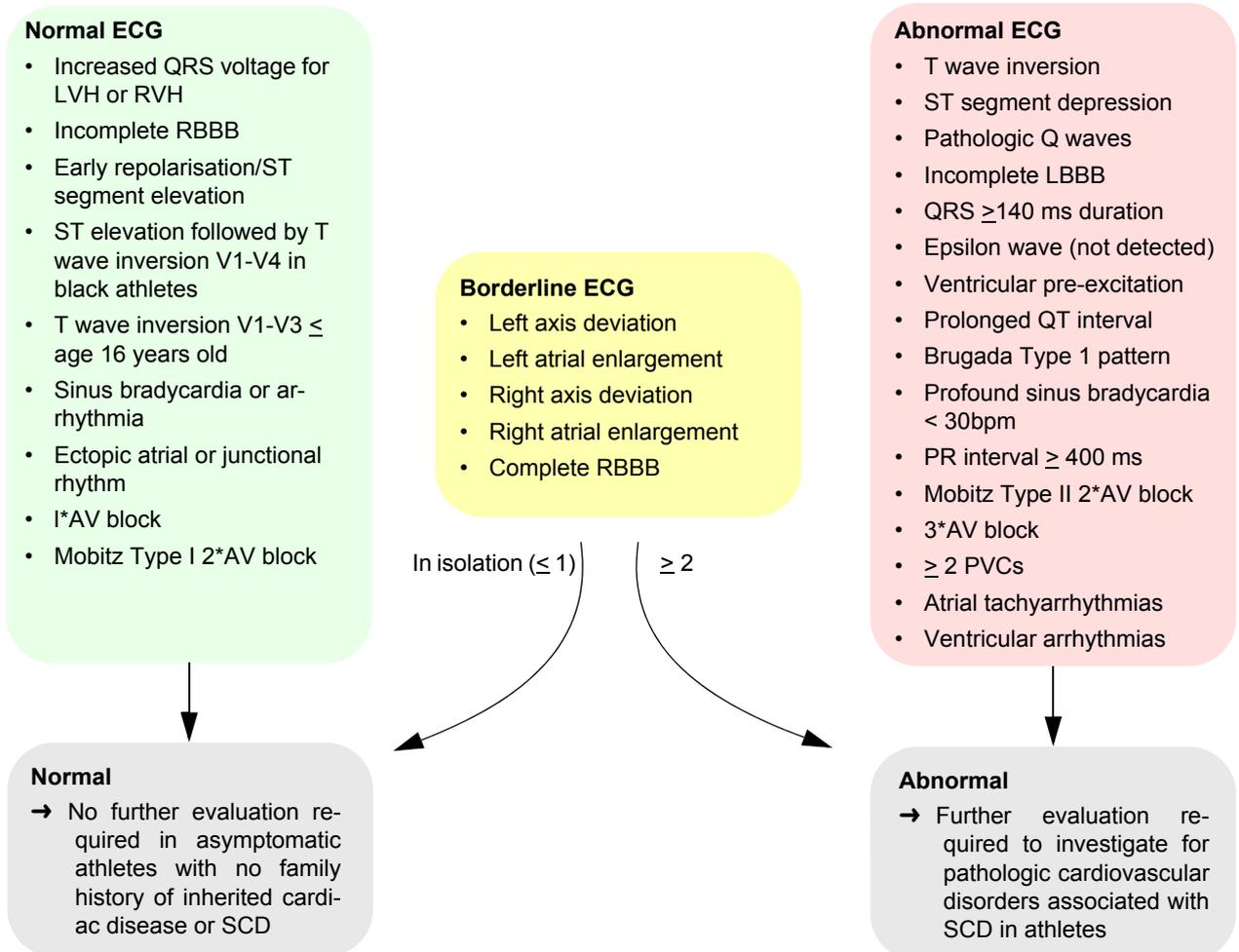➜ No further evaluation required in asymptomatic athletes with no family history of inherited cardiac disease or SCD

Abnormal
➜ Further evaluation required to investigate for pathologic cardiovascular disorders associated with SCD in athletes

Art. no.: 2.511360 Rev. a

9.1.9   LVH

Left ventricular hypertrophy (LVH) refers to an increase in the size of myocardial fibres in the main cardiac pumping chamber. Such hypertrophy is usually the response to a chronic volume or pressure overload. The two most important pressure overload states are systemic hypertension and aortic stenosis. The major conditions associated with left ventricular volume overload are aortic or mitral valve regurgitation and dilated cardiomyopathy. Ventricular septal defects cause both right and left ventricular volume overload, while hypertrophic cardiomyopathy is an example of an inherited condition in which LVH (usually with asymmetric septal hypertrophy) occurs in the absence of any apparent hemodynamic pressure or volume overload. A physiologic type of hypertrophy with increase in wall thickness and left ventricular end-diastolic volume may occur in trained athletes. The athletic heart is often associated with electrocardiogram (ECG) voltage criteria for LVH.

LVH Criteria and Measurements

The LVH criteria displays the raw data in for Sokolow-Lyon, Cornell, Lewis, and Romhilt-Estes given as mV: **1mm = 0.1mV**

The Sokolow-Lyon index

- S in V_1 or V_2 + R in V_5 or V_6 (whichever is larger) ≥ 3.5 mV
- R in aVL ≥ 1.1 mV

Cornell voltage criteria

The sum of the R wave in lead aVL and the S wave in lead V_3. The Cornell criteria for LVH are:

- S in V_3 + R in aVL > 2.8 mV (men)
- S in V_3 + R in aVL > 2.0 mV (women)

Lewis

- RI + SIII - RIII - SI
- If the value is greater than or equal to 1.7 mV, left ventricular hypertrophy can be assumed.

Romhilt-Estes point score system

Diagnostic >5 points; Probable = 4 points:

ECG Criteria	Points
Voltage Criteria (any of): – R or S in limb leads ≥2.0 mV – S in V_1 or V_2 ≥3.0 mV – R in V_5 or V_6 ≥3.0 mV	3
ST-T Abnormalities: – ST-T vector opposite to QRS without digitalis – ST-T vector opposite to QRS with digitalis	3 1
Negative terminal P mode in V_1 1 mm in depth and 0.04 sec in duration (indicating left atrial enlargement)	3
Left axis deviation (QRS of -30° or more)	2
QRS duration ≥0.09 sec	1
Delayed intrinsicoid deflection in V_5 or V_6 (>0.05 sec)	1

9.1.10 Vector Cardiogram

ℹ️ Vector cardiograms and measurements can be displayed when leads Frank, or standard + X, Y, Z have been taken on the original recording.

With the vector option, X, Y, Z leads can be calculated to enable vector cardiograms to be generated from a standard 12 lead recording.

Select **Vector ECG** 📊 .

A vector cardiogram traces the direction and magnitude of the heart's electrical activity during a cardiac cycle. It is produced from the three orthogonal leads X, Y, Z. The size (magnitude) and the direction of a vector are indicated by three spatial coordinates (X, Y and Z). The shape, the direction of the rotation, the orientation and the speed of rotation of the individual loops are the predominant factors for the analysis of the vector cardiogram. Vector loops are represented spatially and projected on the following three planes:

- Horizontal plane (X, Z)
- Frontal plane (X, Y)
- Sagittal plane (Z, Y)
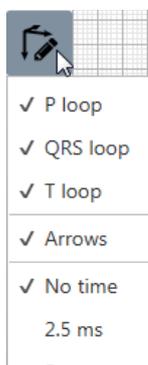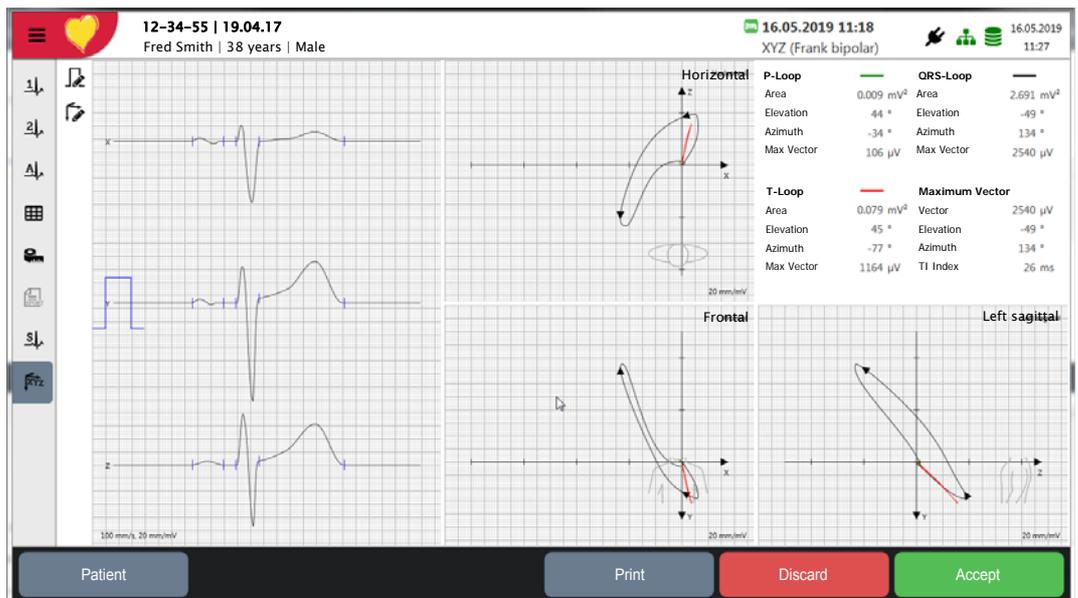
The averages are displayed on the left side and the measurements for each loop are displayed on top right.

The P wave, QRS and T loops can be displayed in any combination. Direction arrows and time markers can be set for display on the loops as required.

The TI parameter (TI Index) is the time interval starting with the maximum QRS vector to the end of the electrical ventricular activation. This parameter can be used as a predictor of response to cardiac resynchronization therapy. [1] [2]

[1] T. Schau et al., "Baseline vectorcardiography as a predictor of invasively determined acute hemodynamic response to cardiac resynchronization therapy," Clin Res Cardiol, vol. 102, no. 2, pp. 129–138, Feb. 2013.

[2] W. Koglek, J. Brandl, A. Oberbichler, K. Schmidt, G. Grimm, and C. Butter, "Dreidimensionale Vektorkardiographie zur CRT-Responderbestimmung," Herzschr. Elektrophys., vol. 17, no. 1, pp. i28–i36, Apr. 2006

9.2 Resting Rhythm Recordings

9.2.1 Rhythm View

Click the Rhythm 1 icon ⬇ or Rhythm 2 icon ⬇ to display all leads as single column or two columns resp. The scale adjusts automatically for the length of the recording and is displayed on the bottom. To jump to another time segment, move the time cursor. The time can be nudged forward or backward by clicking to the left or right of the time cursor.

Add event icon - the event is shown on the rhythm screen and referenced in the event column (next page)
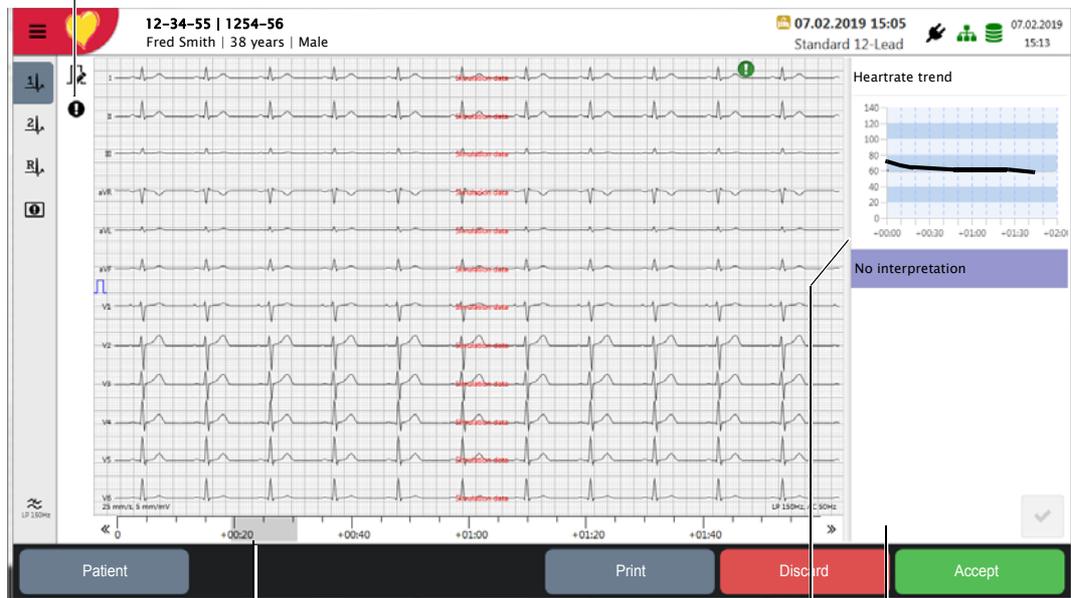
The width of the time position cursor indicates the time segment of the waveforms displayed. Move to scroll through the recording or use the arrow button on either end of time scale.

Space for report

Heart rate trend

9.2.2 Events

Events are indicated in the recording. The events are coloured coded for the type of event as follows:

🟢 Green   Manual event, device NIPB measurement, manual NIBP measurement
🔴 Red   Arrhythmia
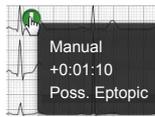
Event Details

- Hover over the event to display the event details.
- To keep the event details displayed, click on the event.

Adding a (Manual) Event

Click the manual icon in the side bar to activate it, the cursor changes to a cross (**+**). Move the cursor in the ECG trace to the required position and click.

Enter the event annotation as required. The event is referenced in the recording. The event text can be added freely or manual event text can be defined for selection in system settings (see para. 13.8, Rhythm ECG, page 132).

9.2.3 Events View

Click the **events icon** [**0**] in the side bar to view all events.
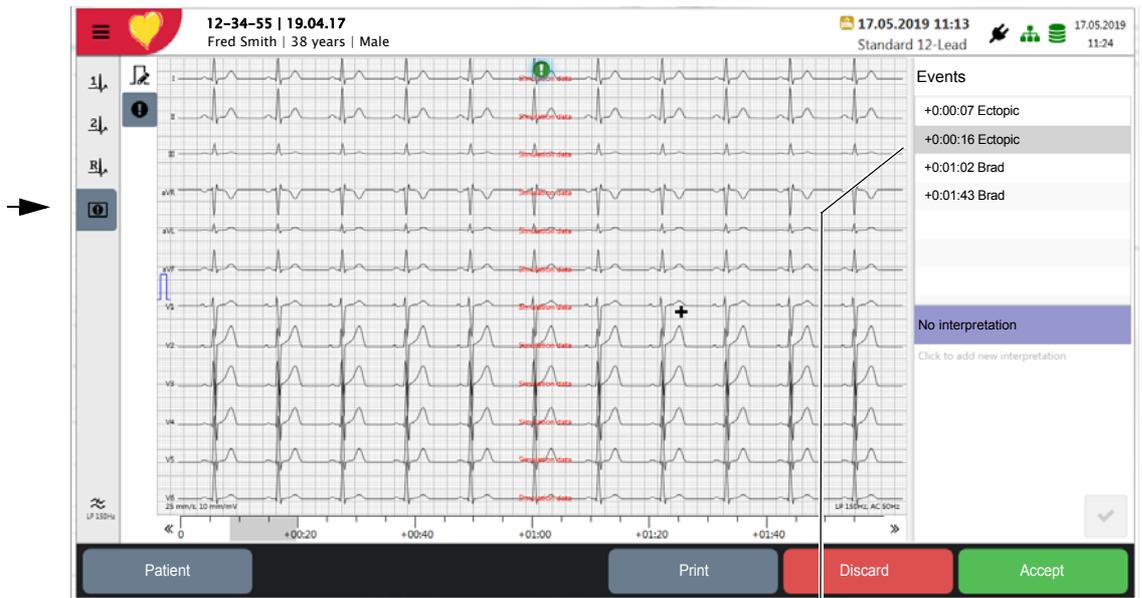
Click on an event in the table on the right hand side to display the ECG trace where the event occurred.

9.2.4   Continuous View

Click Continuous Rhythm icon $\boxed{\text{R}\!\!\downarrow}$ to display a single channel over the entire recording (full disclosure). The lead is selected in the side bar with the lead selection:
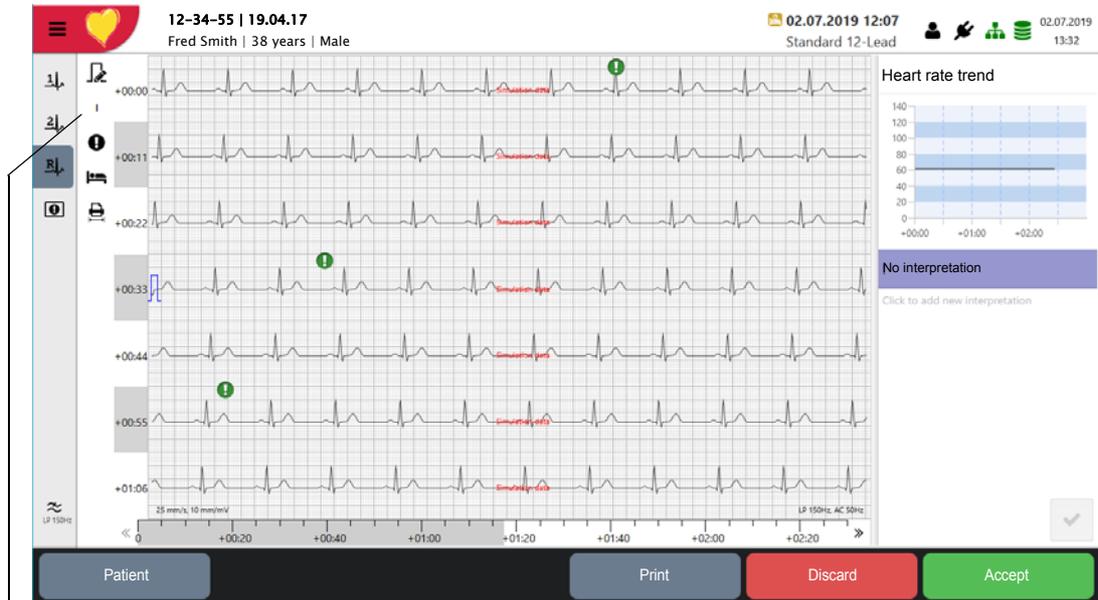
Select the lead in Rhythm view

9.2.5   Creating a 10 s Resting ECG

A 10 s resting ECG can be created from the continuous view as follows:

Select and click to generate a 10 s ECG —

Create resting ECG function button —
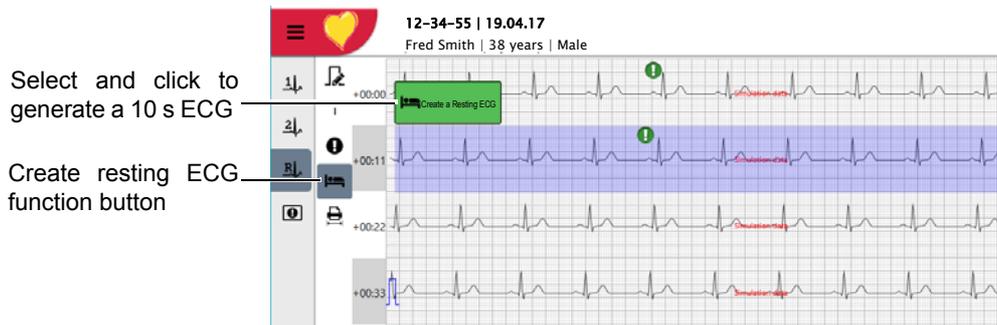
1.   Click the create a resting ECG icon.
2.   A 10 second area of the rhythm recording is highlighted blue.
3.   Move the highlighted area to the rhythm section where you wish to create a 10 s resting ECG
4.   Click **Create a resting ECG**.

A standard 10 s resting ECG with measurments and interpretation is created and will be exported and/or displayed in the memory as defined in system settings.

9.2.6   Printing a Selected 10 s Section from the Rhythm

A 10 s resting section of the Rhythm ECG can be printed from the continuous view as follows:

Select and click to print a 10 s ECG

Print 10 s function button
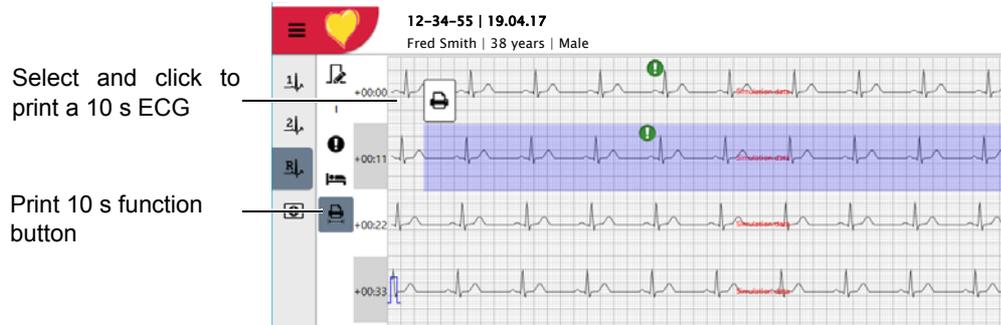
1. Click the print 10 sec icon.
2. A 10 second area of the rhythm recording is highlighted blue.
3. Move the highlighted area to the rhythm section that you wish to print
4. Click **the print button.**

The selected 10 second section highlighted is printed.

9.3   Signal Averaging ECG

9.3.1   Summary
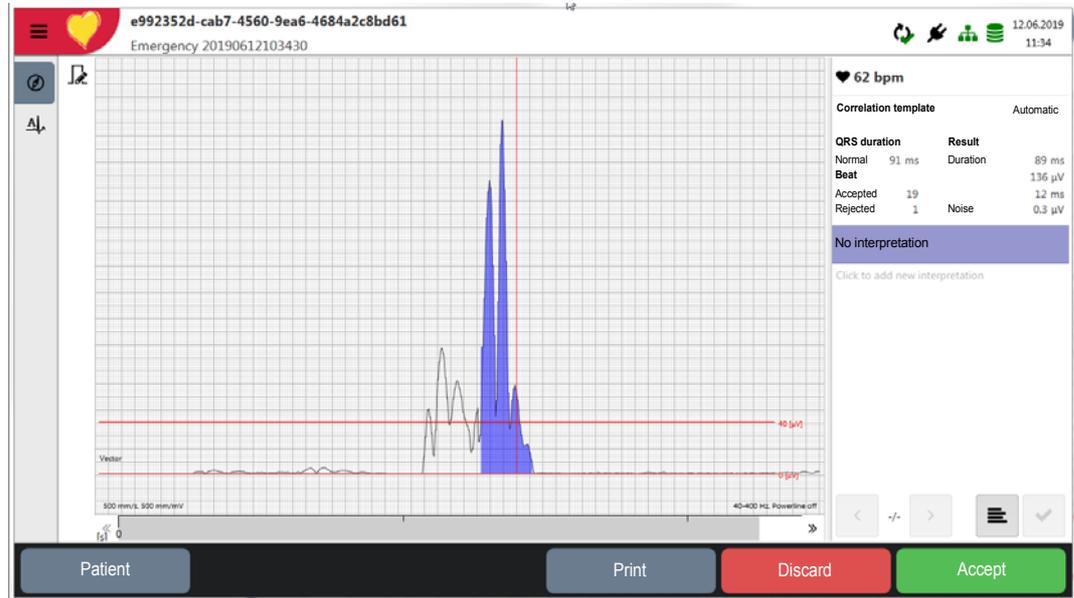
Vector Magnitude

The vector magnitude is calculated from the filtered X, Y, Z leads. The program generated QRS trigger point is indicated by red vertical lines. This is the point where the QRS in the vector magnitude (seen from the T wave) reaches 40 µV for the first time.

The blue shaded area indicates the RMS (40 ms) value and provides a visual indication for the RMS (40 ms) value.

The 40 µV level, and the 0 µV level, are indicated by horizontal red lines.

Result and Information Area

Correlation Template

This is the lead used for the QRS measuring point (defined in master lead / slope) at the start of the recording. It can be X (+ or -), Y (+ or -), or Z (+ or -), or automatic. This is defined in system settings - master lead/slope (see para. 13.10, Signal Average ECG, page 138).

QRS Duration

Averaged QRS duration (over the accepted complexes) in ms.

Result

The results are referenced to the beginning and end of the QRS complex.

- **Duration** - QRS averaged high frequency duration (over the number of accepted QRS complexes) (ms).
- **RMS (40ms)** - the RMS value over the complete segment 40 ms before the end measurement point.
- **LAS (40uV**) - Low amplitude signal - the time between the end of the measurement point and the point where the vector magnitude crosses the 40 µV level (ms).
- **HF noise** - the average high frequency noise over the accepted complexes (µV).

Beat

- **Accepted** - number of accepted QRS complexes used.
- **Rejected** - number of rejected QRS complexes.

9.3.2 Averages
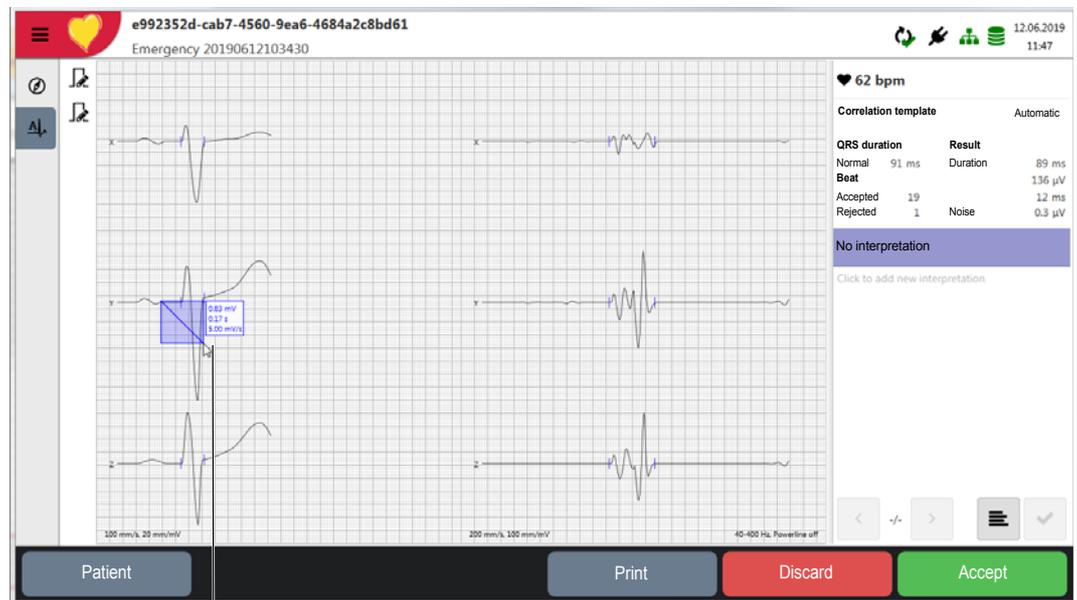
Measurements can be taken by tapping the complex.

Use the icons by the side of waveforms to change the amplitude and speed (X scale). Different proportional scales are given for unfiltered, filtered and vector magnitude.

Unfiltered Averages

Unfiltered averaged QRS complexes in the leads X, Y, Z.

Filtered Averages

Averaged QRS complexes X, Y, Z after filtering.

Note: The filter cut-off setting is 25 or 40 Hz according the to settings or config view before the SAECG recording was started.

9.4 Exercise ECG

9.4.1 Summary

Select the **Summary** icon ⊘ .

Double clicking in the step will enter the ECG step view
(to display the last 10 seconds of the selected stage).
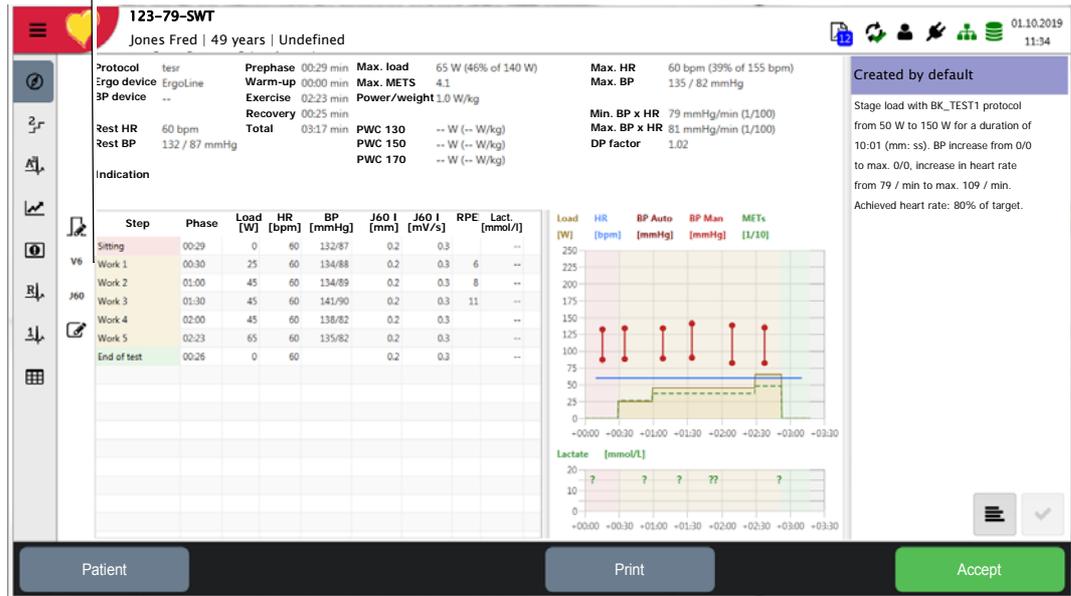
ℹ️   In all screens, where step data is displayed (in the example above the step table, and the heart rate /load/BP graphic), the steps are colour coded to help identification. The colour codes are as follows:

- Prephase- light pink
- Warm-up step - light blue
- Work steps - light brown
- Recovery steps - light green

Test Summary

The test summary in upper section gives the following:

Protocol

The protocol name (if the protocol has been modified during the test, a * is shown next to the name).

Ergo and BP device

Hardware used for the test.

BP Device

The blood pressure device used for the test.

Rest. HR, Rest. BP

The resting heart rate and blood pressure taken before the test commences.

Prephase, Warm-up, Exercise, Recovery and Total

The duration (minutes) of each phase of the test.

Maximum Load

Watts (bicycle) - maximum load achieved in Watts, and percentage of actual load reached against expected load (the expected load is calculated from the patient data including age, gender and height).

Maximum METS

The maximum metabolic equivalent achieved.

Power/weight

The maximum Watt per kilogram achieved.

PWC 130/ 150/ 170

Physical Working Capacity (**PWC**) is the mechanical power of a human being expressed in Watts at a defined heart rate. It makes statements about the long-term performance of the subject. The indications at heart rate of 170, 150 and 130 beats per minute are common and expressed as PWC 170 PWC 150 and PWC 130. The indication is also commonly given as PWC per kilogram of body weight; the determined PWC is thus divided by the body weight of the subject. Standard values for the PWC 170 for untrained, normal weight persons are 2.0 W / kg in women and 2.51 W / kg in men (R. Rost, W. Hollmann: Belastungsuntersuchungen in der Praxis. Georg Thieme Verlag, 1982, S. 85).

The **Standard Values for PWC 130,150,170** are given in the following table. The values in bold are considered standard values.

All values in Watts per kilogram of body weight.

	PWC 130		PWC 150		PWC 170	
	Woman	**Men**	**Woman**	**Men**	**Woman**	**Men**
Very good performance	>2.00	>2.40	>2.50	>3.00	>2.90	>3.50
Good performance	1.60-1.99	1.9-2.39	2.00-2.49	2.50-2.99	2.4-2.89	3.00-3.49
Satisfactory performance	**1.30**-1.59	**1.5**-1.89	**1.60**-1.99	**2.00**-2.49	**2.00**-2.39	**2.50**-2.99
Unsatisfactory performance	1.01-1.29	1.11-1.49	1.20-1.59	1.5-1.99	1.61-1.99	2.01-2.49
Insufficient efficiency	<1.0	<1.10	<1.20	<1.5	<1.6	<2.0

Maximum Heart Rate	Maximum heart rate achieved during the work/recover step and the percentage of the expected heart rate (in parentheses).
Max BP (Sys/dia)	The blood pressure taken in the Step with the maximum load.
Min / Max BP x HR	The min/max systolic blood pressure during the exercise stage multiplied by the heart rate at the end of that stage. Min is the BP at rest, Max is the BP in the step with the highest load.
DP Factor	Double Product Factor is the value of (Max BP*HR) / (Min BP*HR).

Step Table

The headings (data) that is displayed in the step table can be defined by the user. Left click to display the options available.

i Changing the column heading can be performed when a mouse is connected to the device. When set the column order is retained.

The step table gives an overview of the complete test with the any combination of the following information, for each stage:

Phase	Duration of phase
Load	Load applied
SpO$_2$	SpO$_2$
METS	METS value
HR	The maximum heart rate measured at the end of step. The HR values can be edited and new values entered .
BP	The blood pressure measured during the stage. If more that one measurement has .been entered during a stage the last entered measurement is given. The BP values can be edited and new values entered (see following).
Jxx (mm), Jxx (mV/s)	The averaged ST elevation (mm) and slope (mV/s) in the selected lead. The point where the ST is measured can be user defined (see J+x point set next page).
RPE	Rating of perceived exertion (RPE is a subjective indication for patient exertion).

9.4.2 Editing the Results in the Step Table

Values that can be edited are highlighted and can be edited/added for every stage of the test. The following values can be edited:

- Heart rate
- Blood pressure
- Lactate

9.4.3 Editing the Heart Rate

To edit click the edit icon 📝 . Double click on the value and edit as required.
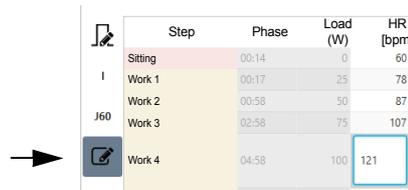
9.4.4 Entering/Editing Blood Pressure

- To **edit a BP measurement** click the edit icon 📝 and then click on the measurement in the graph.

- To **enter a new BP measurement** click the edit icon 📝 and click in the graph where the BP measurement is to be positioned.
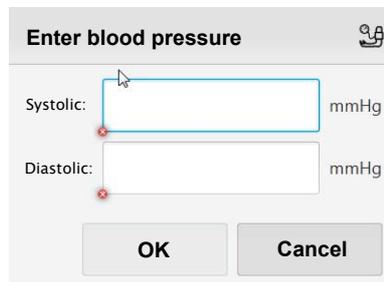
9.4.5   Entering/Editing Lactate Values

- To **enter a new lactate measurement** click the edit icon 🖊 and click in the lower graph where the lactate measurement is to be positioned. Lactate event markers taken during the test are indicated by a question mark in the graph.

- To **edit a lactate measurement** click the edit icon 🖊 and then click on the measurement in the lower graph.
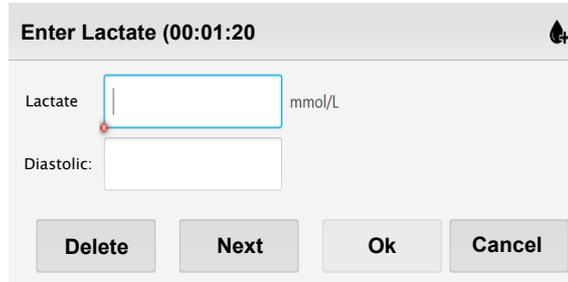
- The lactate value is given in the step table and also provide a trend view in the graphical area

Lactate marker set during the test

Lactate value entered
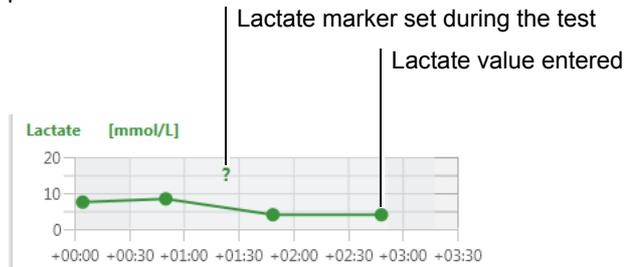
9.4.6   Changing the ST Measuring Point (J+x)

To change the ST measuring point, click Jxx edit icon and select a value between J10 and J100 (J-point plus 10 to 100 milliseconds). When this is changed, the slope and elevation are displayed with the redefined ST measuring point.

9.4.7 Step Rhythm

Click the **Step Rhythm icon** ⌐.

The waveform displays the last 10 seconds of the selected stage and the ST elevation and slope.

ST elevation
and slope

Select next/previous stage
with arrow icons
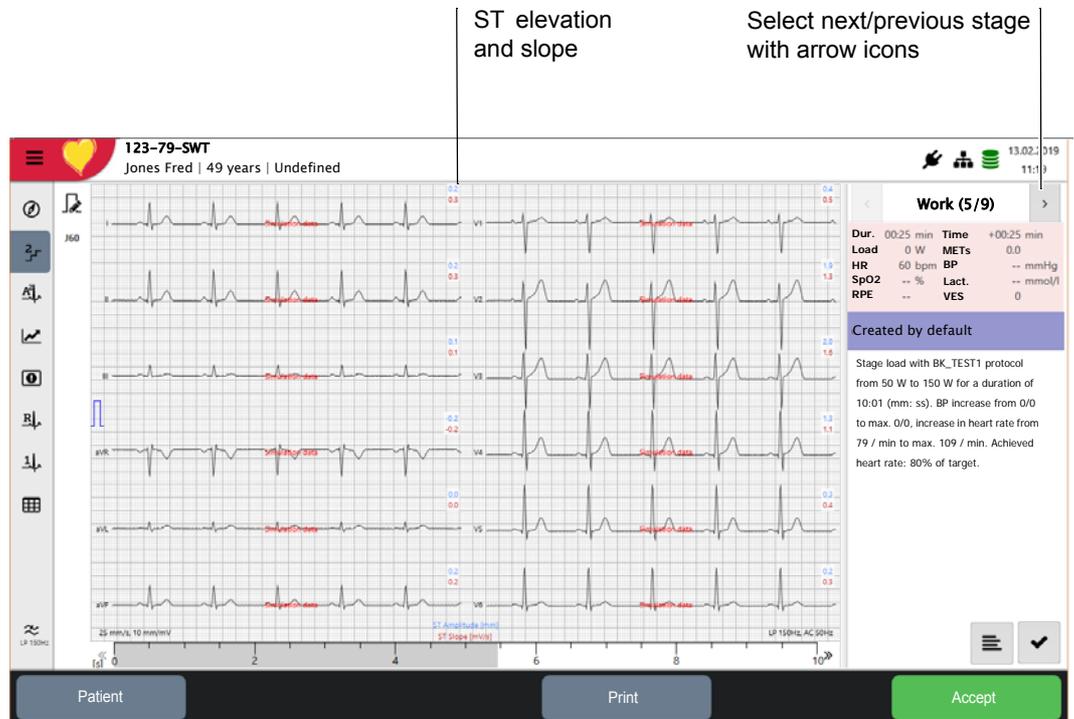
At the side of the page the stages of the test are indicated:

- The step type (warm-up, work, recovery)
- Stage load applied
- Phase duration and time from the beginning of the test
- BP
- HR
- SpO2
- RPE
- VES
- Lactate
- METS

9.4.8   Average View

Click the **average icon** . The averaged view displays the averaged complexes for all leads and all stages of the test (two columns for complexes for each exercise stage).

The two red and blue numbers in the top right of every averaged complex give the ST elevation (mm) and slope (mV/s).

The stage header gives the stage (warm-up, work, recovery), load and heart rate at the end of stage. Phase duration and time from the beginning of the test. Also included are BP, SpO$_2$, RPE, VES, METs, and Lactate if entered.
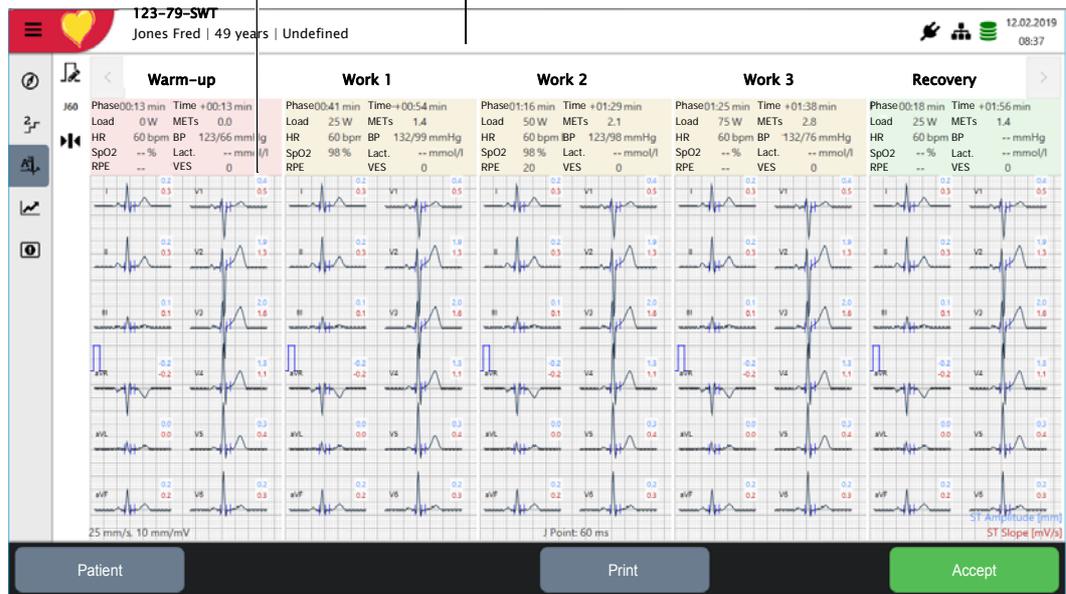
Isoelectric and Reference curve

i

Isoelectric lines and reference curves can also be displayed in the average view. These are set in system settings (see para. 13.9.3, Averages, page 134). When selected, the reference curves are superimposed in blue on the average complexes and the isoelectric line, in grey.
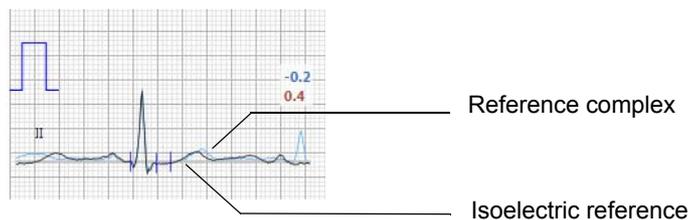
Reference complex

Isoelectric reference

Displaying the Average Complexes for Pre-test Stages, Max load, ST Max and Recovery Stages

Click the max average icon ⏮ in the side bar to display average ECG complexes for **Pre-test, Max load, ST max** (during the work stages), **Recovery** and **End of test.**

9.4.9 ST Trend View

Click the **ST Trend icon** 📈 to display the ST measurements in a graphical format for every lead. The blue line indicates the amplitude in mm. The red line gives the slope in mV/s.
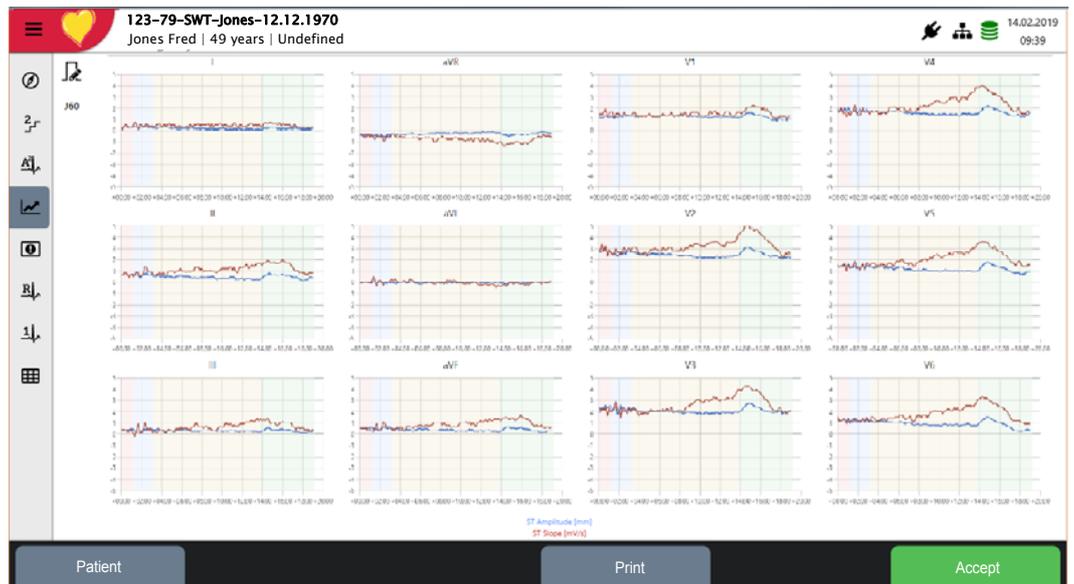
9.4.10   Rhythm View - Continuous (Full Disclosure Single Lead)

Click the **Continuous (Rhythm) icon** R↓ to display full disclosure of the whole test for each lead.

The scale adjusts automatically for the length of the recording and is displayed on the bottom. Step information and interpretation are displayed on the right.

Print 10 s section

Define Rhythm lead

Add Event

Events are indicated. Hover over the event to display the type of event (click the event to keep details displayed). The events are colour coded for the type of event.

Select next/previous stage with arrow icons

The width of the time position cursor indicates the time segment of the waveforms displayed - when the speed is changed the width of the position cursor will change. Move through the recording by moving this bar or by selecting the exercise step (top right).

Double click anywhere in the trace to display the Full Disclosure of all leads (see next page) at the time where clicked.

Events

Click the **Event icon** 🛈 to display Events. Manual events are displayed, edited, deleted and new events defined to all rhythm views as described in the Rhythm recording section. The list of events is available in the Event view.

Printing a Selected 10 s Section from the Rhythm

A 10 s section of the Rhythm can be printed by selecting the 10 print icon 🖶 (see para. 9.2.6, Printing a Selected 10 s Section from the Rhythm, page 93).

9.4.11   Rhythm View - Full Disclosure All Leads

Click the **Rhythm icon 1** 1↓ to display all leads.

9.4.12 ST Table

Click the ST Table view icon ⊞ to display the ST measurements for every lead and every step. The J+xx point can be changed by selecting the icon top left.

Select to change J+xx point

10 Memory

Locally stored recordings can be viewed (without editing function) and can be printed, deleted, and/or can be transmitted to Schiller Link, SEMA or a memory stick in PDF format.

Main menu

B Worklist

B Recorder

→ Q Memory

B Settings

B Maintenance
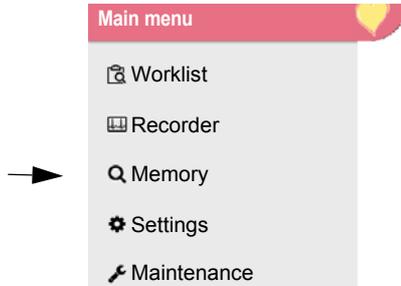
Notes:

- The memory function only displays recordings that are saved locally. Recordings that have been exported may not be available for view in the CARDIOVIT AT-180.
- A system setting can auto export a recording after it has been made and accepted (saved) and, after export a system setting can delete a recording form the local recording memory (see para. 13.7.9, Workflow, page 132).
- Recordings that are stored locally can be viewed but not edited. Recording editing is only available immediately after a recording has been made (before it is saved). Once saved, recordings can only be edited in SEMA.

- Memory capacity is indicated by the icon 🗄 in the status bar:
    - green = memory OK
    - yellow = almost full
    - red = memory full, no more recordings can be performed

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10.1   Searching for a Recording from Memory

When the memory screen is entered, all locally stored recordings are displayed. Recordings can be sorted alphabetically, or by date, patient ID, visit ID, or sync state.

Check box to select for view, export, or to delete

Type of recording (Resting, Rhythm, signal average, exercise)

Search for specific patient

Sort recordings

Symbol Indicates recording has been exported.

10.1.1   Viewing a Recording

1. Select the recording using the checkbox in the memory screen.
2. The **View recording icon** (bottom left) becomes active to open the recording.

i   Only one recording can be selected for view. If more than more than one recording is selected, for example for deletion or transmission, the View recording icon is not active.

10.1.2 Deleting a Recording

1. Select the recording(s) using the checkbox in the memory screen.

2. Select the delete icon in the side bar 🗑 .

3. You are prompted to confirm.

Delete recording(s) ❓

Are you sure you want to delete the 2 selected recording(s)?

| Yes | No |

ℹ
- If you wish to delete all recordings use the **select all** icon to select all recordings in the memory.

10.1.3 Manually Exporting Recordings

1. Select the recording(s) using the checkbox in the memory screen.

Recordings successfully exported

2. Select the export icon in the side bar ♻ .
   – During the export process, an icon appears in the top right of the screen, showing export progress.
   – When the recording(s) have been successfully exported the export symbol in the top right of the screen is ticked. Recordings may also be deleted from the memory when exported (and then not listed locally). This is a system setting (see para. 13.7.9, Workflow, page 132).
   – If for any reason a recording cannot be exported, it remains stored locally and indicated with an export symbol with a red cross by the side and the number of recordings that have not been unsuccessfully exported 🔄.

ℹ
- Only recordings that have not been exported previously can be exported manually.
- The location where the recordings are exported is defined in system settings.
- Recordings can exported automatically when taken. This function is set is system settings (see para. 13.7.9, Workflow, page 132).
- When **Select all** icon is selected, the whole list of recordings can be exported.
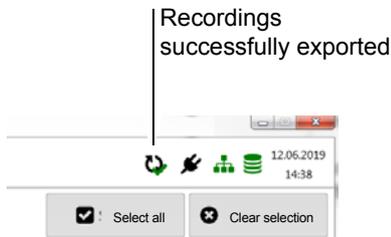
11 Worklist

11.1 Introduction

The Worklist function enables a doctor / administrator to define a worklist of patients that require recordings to be made. The doctor can define the patient, room / department, and specify the type of recording to be made. The worklist is defined directly from the Hospital information system (HIS); once the recording has been made by the CARDIOVIT AT-180, it is sent back to the HIS for analysis, examination and storage.

i

- A worklist can be sent to a specific device or to all devices connected to SCHILLER server. To receive a worklist from the Schiller Server, the device identification of the CARDIOVIT AT-180 (device ID in the system) must be the same as the one defined for the workitem. This device ID is usually set when the device is first commissioned. The Device ID is shown in **Menu** > **Settings > General > Station**.
- When "Undefined" is set instead of type of recording only the patient demographics are sent to the device.

11.2 Receiving a Worklist

To open the worklist select **Menu** > **Worklist**

Search recordings

Work item details

When the worklist is opened all work items for the device are automatically downloaded.

Sync. Worklist
10:45:59
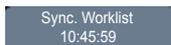
The Work items are then synchronised every minute; the time of the last synchronisation is shown on the Sync. Worklist icon. The worklist can be updated at any time by selecting the Sync. Worklist icon.

All patients given in the worklist are displayed with their last/first name, patient ID, order ID and room number. The following recording types are available:

- Resting ECG
- Resting rhythm ECG
- Exercise ECG
- SAECG
- Undefined recording type. The recording type is assigned when the recording is performed.

Recording Status

- White background = recording to be performed.
- Blue background = selected recording.
- Green background = recording taken. The next time the worklist is synchronised, these recordings are deleted from the list.
- Red background = recording was cancelled.

11.2.1 Performing a Worklist Recording

i

- Patient data provided by the HIS cannot be edited (except for height and weight)

1. Prepare the patient and select a work item.
2. Check the **Work item details** and patient data next to the work item.
3. Select **Resting/Rhythm/SAECG/Exercise**.
4. The corresponding recording acquisition screen is opened. If no recording type has been defined, all options are available.
5. Take the recording.
6. After saving the recording, the workitem will be displayed in the worklist with green background.

11.2.2 Sending Worklist Recordings to the HIS

i

- It is possible to automatically send performed worklist recordings. This is defined in system settings (see para. 13.7.9, Workflow, page 132).
- Recordings can also be transmitted manually from the memory.

11.2.3 Deleting a Work Item

Delete Order

→   Select the work order and select **Delete Order.**

12 Transmission

⚠ **CAUTION**

⚠

▲ Security of the network is the sole responsibility of the network operator.

▲ In order to guarantee the security of the network, Schiller AG recommends the following:

– isolating the CARDIOVIT AT-180 network from other networks.

– defining access authorisation for the configuration of the host system, incl. CARDIOVIT AT-180, so that no unauthorised alterations of the system are possible.

– not overloading the data transmission between the host and other systems/ networks to help prevent data corruption.

– installing the latest antivirus/firewall programs on the host in order to prevent malware from affecting the system.

– regularly installing security updates on the host.

– installing software updates that increase the security of the CARDIOVIT AT-180.

– taking the appropriate measures to check the system's security and ensure safe operation when changing the network configuration, installing security updates and adding/removing devices.

– applying Risk management of IT-networks according IEC 80001-1.

▲ The transmission of ECG data via WLAN can disturb other devices, including pacemakers. Therefore, keep a distance of at least 30 cm from the patient while an ECG is transmitted.

12.1 Transmission Options

The following transmission options are available:

SCHILLER Server

Schiller Server facilitates the following:

• Patient data queries from a defined EMR/HIS system

• Recording Storage in a defined EMR/HIS system.

• Recording view and editing in SEMA

To activate this communication, set **Schiller Server** in the menu Connectivity > EMR integration .

ℹ

Transmission settings and options are detailed in the SCHILLER Communication Handbook 2.520036.

Schiller Link

Schiller Link offers communication with an EMR system and facilitates PDF storage on a PC, as follows:

• Import of examination requests including patient data and recording type from an EMR system.

• Export of recordings to an EMR system in GDT or PDF format

• Generation of PDF files (to a defined folder that can be used for example, to be sent by email for view or for archiving, etc).

To activate this communication, set **Schiller Link** in the menu Connectivity > EMR integration .

12.1.1   PDF Export to USB

Export of a recording in PDF format to a USB stick.

12.2   Transmission Symbols

12.2.1   LAN or WLAN active/not active

The network symbol in the status bar at the top right, indicates the connection status of WLAN or LAN

- Symbol Green - Connected to network and SCHILLER Server
- Symbol Black - Connected to network but no connection with SCHILLER Server
- Symbol black and a cross in the symbol - no network connection

- Symbol Green - Connected to Wifi network and SCHILLER Server.
- Symbol Black - Connected to network but no connection with SCHILLER Server
- The strength of the signal is indicated with the number of bars.

12.2.2   During Transmission

When a recording is being saved, a saving symbol appears temporarily in the top right of the screen.

12.2.3   Transmission OK

When a recording has been successfully transmitted it is indicated in the top right of the screen.

12.2.4   Transmission Failed

1. Should the network not be available, recordings that have not been transmitted are displayed with the symbol and the number of failed transmissions is displayed.
2. Recordings can be sent manually from the memory.

If no data can be transmitted, check the following:

→ Network settings
→ Network connection WLAN or LAN
→ Encryption settings on the server
→ Settings in the Schiller Link App.

When automatic transmission is active in settings, recordings are automatically transmitted as soon as the network is again available.

12.3　Schiller Server

To activate this communication set **Schiller Server** in the menu Connectivity > EMR integration .

12.3.1　Patient Data Query

Patient data can be retrieved automatically from the Schiller Server to the CARDIOVIT AT-180. This is called patient data query (PDQ). To do this, the Patient or Visit ID is entered in the patient data screen manually or via a barcode reader.

12.3.2　Data Transmission

Data transmission can be automatic or manual.

Worklist

.

Automatic Transmission

.

Manual Transmission

.

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12.4   Schiller Link

Schiller Link is a PC application/service which communicates between the EMR system and the CARDIOVIT AT-180.

To activate this communication, set **Schiller Link** in the menu Connectivity > EMR integration .

➜   Integration in the network is automatic, provided the CARDIOVIT AT-180 is part of the same network as the EMR system.
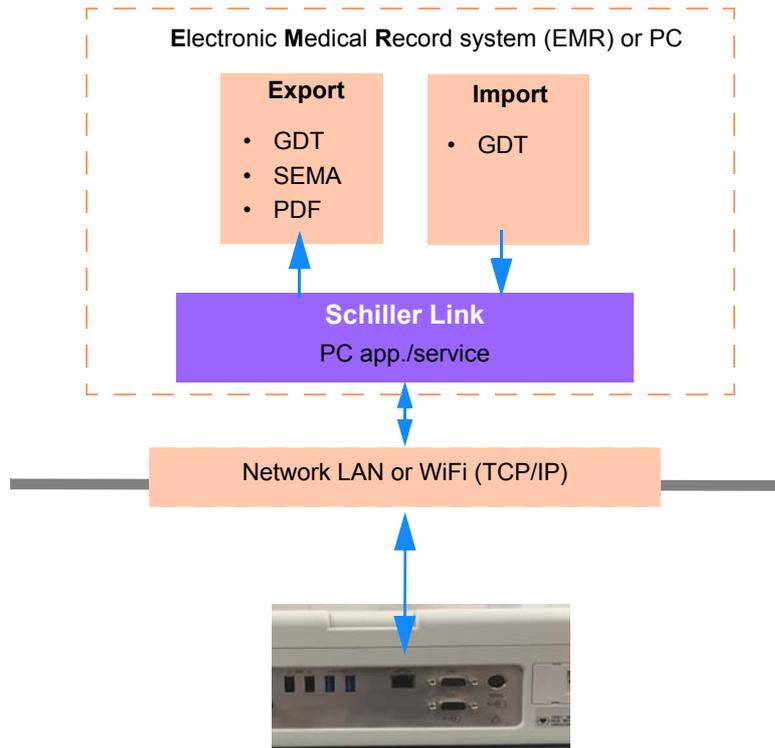
12.4.1   Procedure with EMR system

1.   Enter/select a patient in the EMR system.
2.   Generate a new order for this patient.
3.   The EMR system uploads the GDT file into the import folder of the Schiller Link service.
4.   Start and check the order incl. patient data on the CARDIOVIT AT-180. Should no patient data be displayed, select **Use order data**. The order data will be loaded and displayed.
5.   Perform the recording.
6.   Store the recording and export it automatically or manually to the Schiller Link.
7.   Schiller Link generates the GDT and/or PDF automatically.
8.   The EMR system imports the recording GDT/PDF file automatically.

12.4.2   Procedure without EMR system (PDF)

1.   Manually enter the patient data on the CARDIOVIT AT-180 (via keyboard or barcode reader).
2.   Perform the recording on the CARDIOVIT AT-180.
3.   Store the recording and export it automatically or manually to the Schiller Link.
4.   Review the recording (PDF) on the PC and print or transmit it via e-mail.

Art. no.: 2.511360 Rev. a

12.5   PDF Export to USB

Data integrity

⚠ **CAUTION**

▲   When exporting patient data to a USB stick, the operator needs to take appropriate security measures to protect the data:

– Make sure that only authorised persons have access to the USB stick.

– After data transmission from the USB stick to a secure system, delete all data from the USB stick.

– Deactivate the PDF export function if it is not used.

12.5.1   Saving a PDF of the Recording

In the system settings check **PDF to USB after save** - Main menu > Settings > General > Workflow (see para. 13.7.9, Workflow, page 132).

Caution: If **Delete after export** is activated in the same menu, the recordings are deleted from the memory after exporting.

USB stick

– When active, a PDF file of the recording is produced and copied to a USB stick after the recording has been accepted.

– The symbol   PDF export is displayed when data has successfully been transferred to the memory stick.

– If a USB stick is not attached when a recording is accepted the PDF file is stored and transmitted as soon as a USB stick is connected. When there are PDF recordings that have not been exported to a USB memory this is indicated by the symbol showing how many PDF recordings stored.

• Other PDF settings (page size conformity, etc, are defined in system settings (see para. 13.3.2, PDF, page 122).

• PDF recordings are identified with the following file name format:

– PATIENTID_LASTNAME_FIRSTNAME_yyyy-MM-dd'T'HH-mm-ss_RECORDINGTYPE

– **Example**: PID123_Smith_John_2019-11-15T15-28-33_RestingECG

Art. no.: 2.511360 Rev. a

13   Settings

13.1   Settings Menu Overview

i

The options and settings available are defined according to:

• The options installed and
• The privileges defined for the logged in user

Main menu

- Worklist
- Recorder
- Memory
- Settings
- Maintenance
- Lock
- Logout

Click the SCHILLER icon the top left of the screen to display the main menu and select **Settings.**

Settings ————

Search

ECG
Lead & Cable
Additional lead
Filter
Interpretation
QRS Trigger

Reports
General
PDF
Header
Manual printout
Resting ECG
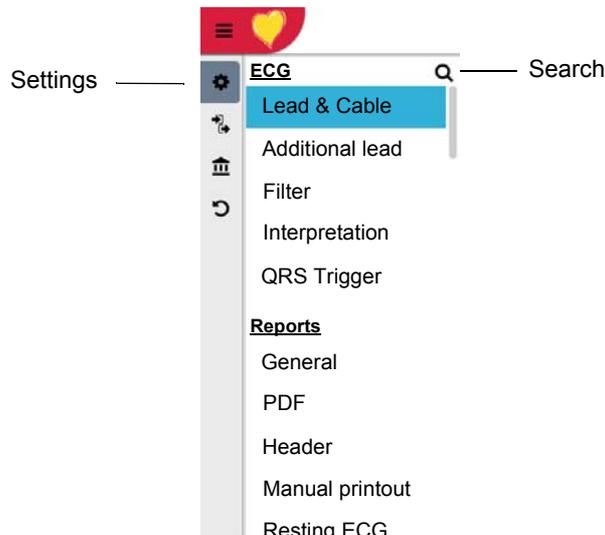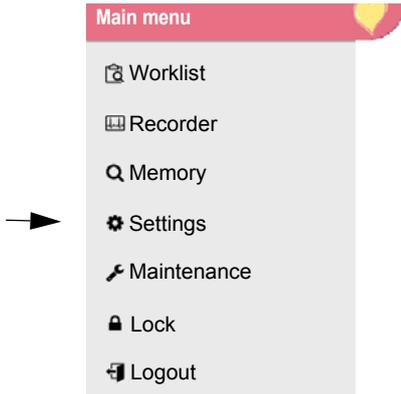
The main settings are sub-divided into the following:

Main Setting	Sub-Menu
ECG	– Lead & cable – Additional Lead – Filter – Interpretation – QRS Trigger
Reports	– General – PDF – Header – Manual printout – Resting ECG – Rhythm ECG – Exercise ECG
Layout (for Resting ECG, Exercise ECG and SAECG)	– Preview Layout – Preview Scale – Review Layout – Review Scale – Colour

Art. no.: 2.511360 Rev. a

Main Setting	Sub-Menu
Connectivity	– EMR integration – Ethernet – WLAN
Regional	– Date / time – Language – Units – Patient ID system
General	– Info – Lock – Power management – Access Control – Station – Mandatory Fields – Update – Manage licenses – Workflow – Printer
Rhythm ECG	– General – Events
Exercise ECG	– General – Actions – Averages – Templates – Ergo devices – Protocols – Protocol editor – Events
SAECG	– General

13.1.1　Saving Settings

Changed settings are saved automatically when the screen is exited.

13.1.2   Importing / Exporting Settings and Factory Reset

Import/ Export Settings —
Export Audit log —
Reset settings to — factory default
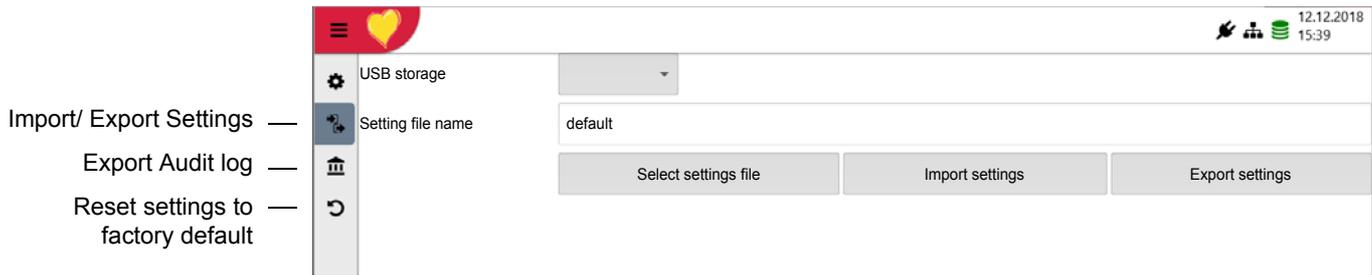
Import/Export Settings	Select USB Storage and enter the file name to import or tap **Select setting files** in order to import or export the files.
Reset to Factory Settings	All settings are reset to the factory defaults. If the network settings are to be reset as well, untick the check box. You are given a warning and asked to confirm before restoring factory settings.
Export Audit log	Export an audit log to a USB stick for analysis by service personnel. Note that the export target (to select the location), is only active when at least one memory device is attached to the device.

Art. no.: 2.511360 Rev. a

13.2   ECG

13.2.1   Lead & Cable

Parameter	Description / selection
Patient cable	**IEC** or AHA
Lead sequence	**Standard** or Cabrera
Default lead config	Any leads can be selected for selection in the ECG screen. The configuration can be selected in any order. The first configuration selected here is the first configuration that will be displayed in the ECG screen (see para. 4.5.1, Selecting the Lead Configuration, page 55).

- • **Balanced**
- • **Standard 12-lead**
- • **Left Posterior**
- • **Standard with C4r**
- • Paediatric
- • Right Precordials
- • Nehb (chest)
- • XYZ (Frank orthogonal)
- • XYZ (Frank bipolar)
- • 12-lead + Balanced*
- • 12 -lead + Right precordials Full*

* when the 14-wire patient cable option is licensed, the extra configurations available are also given.

13.2.2   Additional Lead
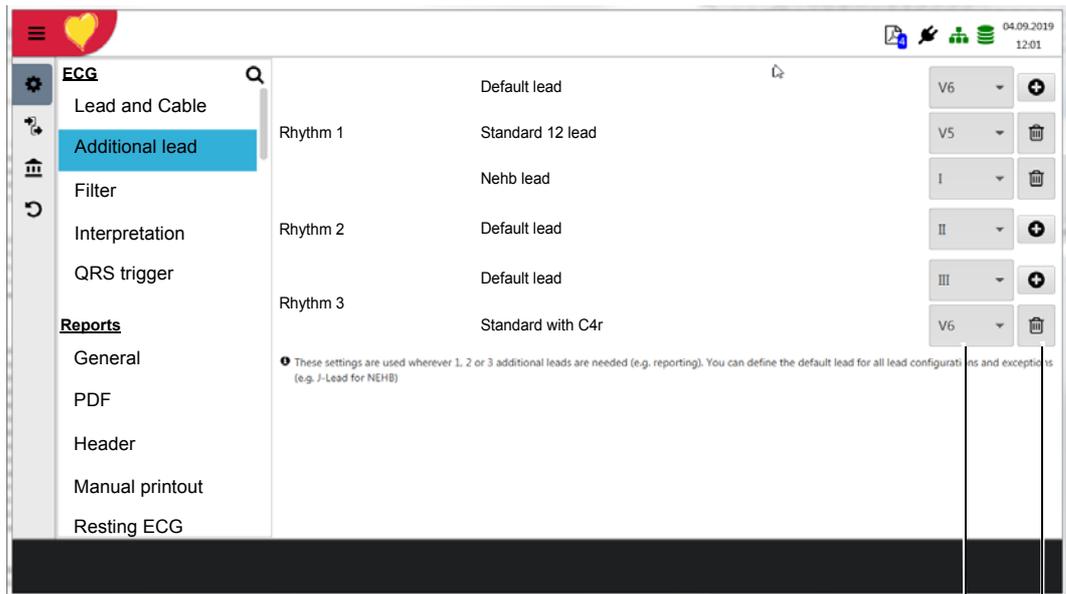
Define lead

Add (or delete) lead for specific configuration

Three additional (rhythm) leads can be specified. These are the default leads displayed in review mode whenever rhythm leads can be viewed. These leads are also the rhythm leads given on reports. Three rhythm leads can be defined for all configurations or up to three additional leads can be defined for specific lead configurations as required.

The leads available for the different configurations are as follows:

Parameter	Description / selection
Rhythm 1 (Default lead)	**I**, II, III, aVR, aVL, aVF, V1 - V6
Rhythm 2 (Default lead)	I, **II**, III, aVR, aVL, aVF, V1 - V6
Rhythm 3 (Default lead)	I, II, **III**, aVR, aVL, aVF, V1 - V6
12 lead + balanced	I, II, III, aVR, aVL, aVF, V4r, V3r, V1 - V9
12 lead + right precordials full	I, II, III, aVR, aVL, aVF, V1 - V6, V3r, V4r, V5r, V6r
Left Posterior	I, II, III, aVR, aVL, aVF, V4 - V9
Nehb (Chest)	I, II, III, aVR, aVL, aVF, D, A, J
Paediatric	I, II, III, aVR, aVL, aVF, V7, V2, V3r, V4r, V5, V6
Right precordials	I, II, III, aVR, aVL, aVF, V1, V2, V3r, V4r, V5r, V6r
Standard 12 lead	I, II, III, aVR, aVL, aVF, V1 - V6
Standard with C4r	I, II, III, aVR, aVL, aVF, V1, V2, V3, V4r, V5, V6

Art. no.: 2.511360 Rev. a

13.2.3   Filter

Parameter	Description / selection
Notch filter	Off / **AC 50** Hz / AC 60 Hz
Resting display filter	Off/LP 25/LP 40/**LP 150 Hz**
Exercise display filter	Off/LP 25/LP 40/**LP 150 Hz**/RNSF

13.2.4   Interpretation

Parameter	Description / selection
Print Interpretation statement only if validated	Check to include only validated interpretations (in printout).
Display Interpretation	Check to show the interpretation (in review mode)

13.2.5   QRS Trigger

Signal output on the QRS trigger output socket on the back panel

Parameter	Description / selection
Delay	0 ms to 150 ms (default is **0 ms**)
Duration	10 ms to 250 ms (default is **50 ms**)

ℹ️ **Trigger Settings when using the SCHILLER BP-200 plus blood pressure device**

When using the BP-200 plus blood pressure unit the recommended settings are as follows:

– Delay: 0 ms
– Duration: 50 ms

The pulse output amplitude is 5 V.

13.3   Reports

13.3.1   General

Parameter	Description / selection
Rhythm mode	**Sequential** or Simultaneous. Select Sequential for consecutive time segments. Select Simultaneous to define the same time segment for all lead groups. If a print format with a rhythm lead is defined, Sequential is used, even if you have selected Simultaneous.
Default QTc calculation	**Bazett**, Fridericia, Framingham, Hodges
Company info 1, 2, 3	Enter company information on the report, lines 1, 2, and 3.

13.3.2   PDF

Parameter	Description / selection
PDF paper format	**A4** or Letter
PDF conformance	select between **None**, PDF/A-1a or PDF/A-1b[1]
PDF Company Logo	Click the company logo field to browse and insert a company logo on a report. The file must be a jpg, bmp, etc. The file can be any size and the program will scale the image to fit.
Use PDF company logo	Check as required. When checked the logo is given on the PDF file. It will not printed on the thermoprint.

1. Part 1 of the PDF/A ISO standard [ISO 19005-1:2005] is a constrained form of Adobe PDF version 1.4 intended to be suitable for long-term preservation of page-oriented documents for which PDF is already being used in practice. Level B conformance (PDF/A-1b) indicates minimal compliance to ensure that the rendered visual appearance of a conforming file is preservable over the long term. Level A conformance (PDF/A-1a) indicates complete compliance with the ISO 19005-1 requirements, including those related to structural and semantic properties of documents (http://www.digitalpreservation.gov/formats/fdd/fdd000252.shtml, accessed March 2013).

13.3.3   Header

Define the information fields and position to be included in the report header, including

- Patient ID
- Date of birth
- Gender
- Height and weight
- Medication
- etc

13.3.4   Manual Printout

In this menu, the default settings for manual printouts are defined.

Parameter	Description
Default lead group	Selection of the lead group: **All**, limb, or precordials
Default amplitude [mm/mV]	5, **10**, 20, 40 mm/mV
Default speed [mm/s]	12.5, **25** or 50 mm/s

13.3.5   Resting ECG

A number of configuration options can be selected for the report and their position in the report can be defined. Different reports can be defined for 9-lead, 12-lead and for 16-lead ECGs.
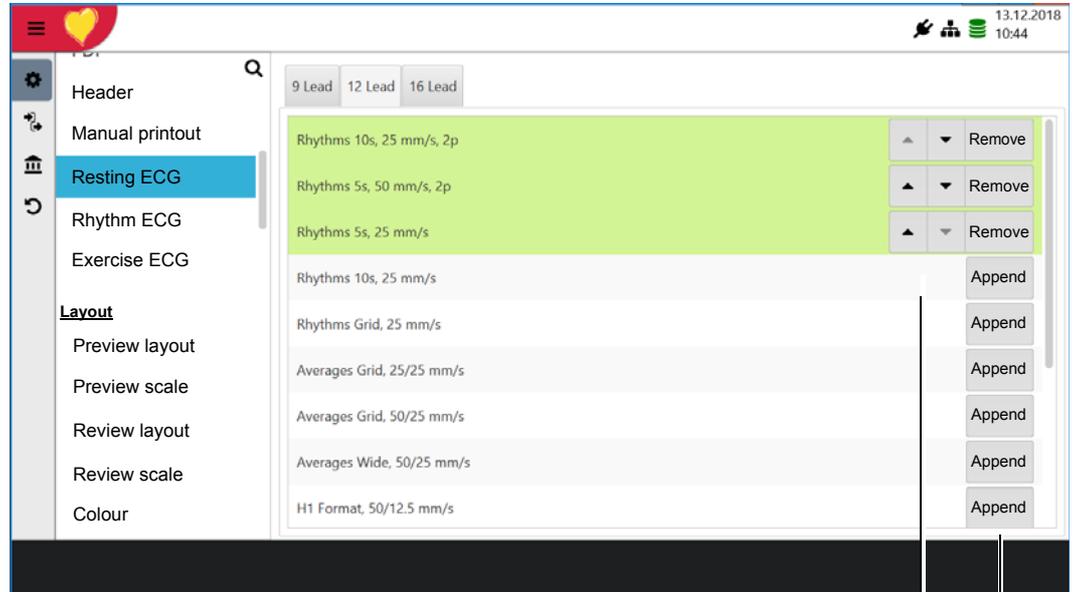
Change order of views

Append or remove view

13.3.6   Rhythm ECG

As for Resting (with different configuration options).

Also included is a separate range printout format (**10 s, 25 mm/s, 1p**, or 10 s, 50 mm/s, 2p) for 10 second printouts extracted from the full disclosure.

13.3.7   Exercise ECG

As for Resting (with different configuration options).

Also included is a stage printout format for step printout during an exercise test (**None**, Step print 5 s, 25 mm/s, Step print 5 s, 50 mm/s, 2 p, or Step print 5 s, 25 mm/s) and a range printout format (**10 s, 25 mm/s, 1p,** or 10 s, 50 mm/s, 2 p) for 10 second printouts extracted from the full disclosure.

13.4 Layout

Here the display layout settings are defined for acquisition (preview) and after a recording has been made (review). Settings include background and text colour, and trace colours and thickness and are defined for Resting, Rhythm and Exercise ECG.

Preview / Review Layout

This defines the icons (views) in the sidebar and their position.

Preview / Review Scale

The rhythm, average amplitude and speed defaults.
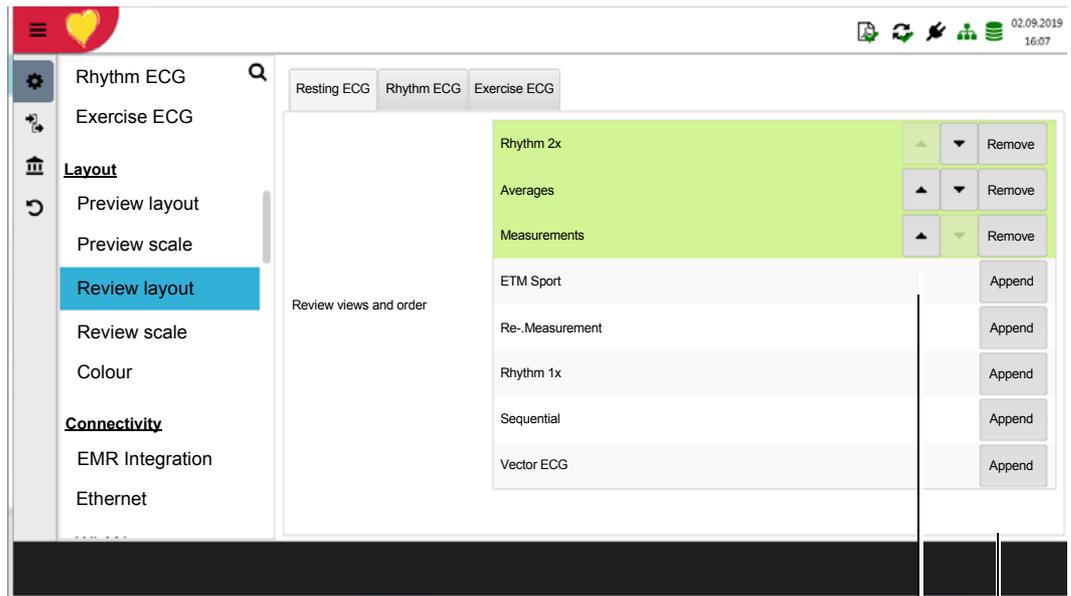
Change order of views

Append or remove view

13.4.1   Preview Layout

Parameter	Description / Selection
Resting ECG	• **Rhythm 2x, Hookup,** Rhythm 1x, Rhythm 4x, Rhythm 1x3/1x4
Exercise ECG	• **Rhythm 2x6, Hookup,** Rhythm 1x6, Rhythm 1x12, Rhythm 4x3, interpretation
Signal average ECG	• **Preview, Hookup, Config**

13.4.2   Preview Scale

Parameter	Description / Selection
Resting ECG	• Default amplitude: 5 mm/mV, **10 mm/mV,** 20 mm/mV • Default speed: 12.5 mm/s, **25 mm/s,** 50 mm/s
Exercise ECG	• Default amplitude: 5 mm/mV, **10 mm/mV,** 20 mm/mV • Default speed: 12.5 mm/s, **25 mm/s,** 50 mm/s
Signal average ECG	• Default rhythm amplitude: 5 mm/mV, **10 mm/mV,** 20 mm/mV • Default rhythm speed: 12.5 mm/s, **25 mm/s,** 50 mm/s • Default template amplitude: 5 mm/mV, **10 mm/mV,** 20 mm/mV • Default template speed: **25 mm/s,** 50 mm/s

13.4.3   Review Layout

Parameter	Description / Selection
Resting ECG	• **Rhythm 2x, Averages, Measurements,** ETM Sport, Remeasurement, Rhythm 1x, Sequential, Vector ECG
Rhythm ECG	• **Continuous, Rhythm 2x, Events,** Rhythm 1x
Exercise ECG	• **Exercise ECG layouts: Summary, Step rhythm 2x, Averages 2x, ST Trend, Events**, Contiuous, Rhythm 1x, ST table

13.4.4   Review Scale

Parameter	Description / Selection
Resting ECG	• Rhythm amplitude 5 mm/mV, **10 mm/mV,** 20 mm/mV • Rhythm speed: 12.5 mm/s, **25 mm/s,** 50 mm/s • Average amplitude **10 mm/mV,** 20 mm/mV • Average speed: **25 mm/s,** 50 mm/s
Rhythm ECG	• Rhythm amplitude 5 mm/mV, **10 mm/mV,** 20 mm/mV • Rhythm speed: 12.5 mm/s, **25 mm/s,** 50 mm/s • Continuous amplitude 5 mm/mV, **10 mm/mV,** 20 mm/mV • Continuous speed: 12.5 mm/s, **25 mm/s,** 50 mm/s
Exercise ECG	• Rhythm amplitude 5 mm/mV, **10 mm/mV,** 20 mm/mV • Rhythm speed: 12.5 mm/s, **25 mm/s,** 50 mm/s • Average amplitude **10 mm/mV,** 20 mm/mV • Average speed: **25 mm/s,** 50 mm/s • Continuous rhythm amplitude 5 mm/mV, **10 mm/mV,** 20 mm/mV • Continuous rhythm speed: 12.5 mm/s, **25 mm/s,** 50 mm/s
Signal average ECG	• Average amplitude **10 mm/mV,** 20 mm/mV • Average speed: **50 mm/s,** 100 mm/s, 200 mm/s • Filtered amplitude **100 mm/mV,** 200 mm/mV • Filtered speed: **50 mm/s,** 100 mm/s, 200 mm/s • Magnitude amplitude **500 mm/mV,** 750 mm/mV, 1000 mm/mV • Magnitude speed: **200 mm/s,** 500 mm/s

13.4.5   Preview / Review Colour

The trace colour to indicate the **quality of the signal**, and the theme background (dark or light). The screen will display the colours as they are entered.
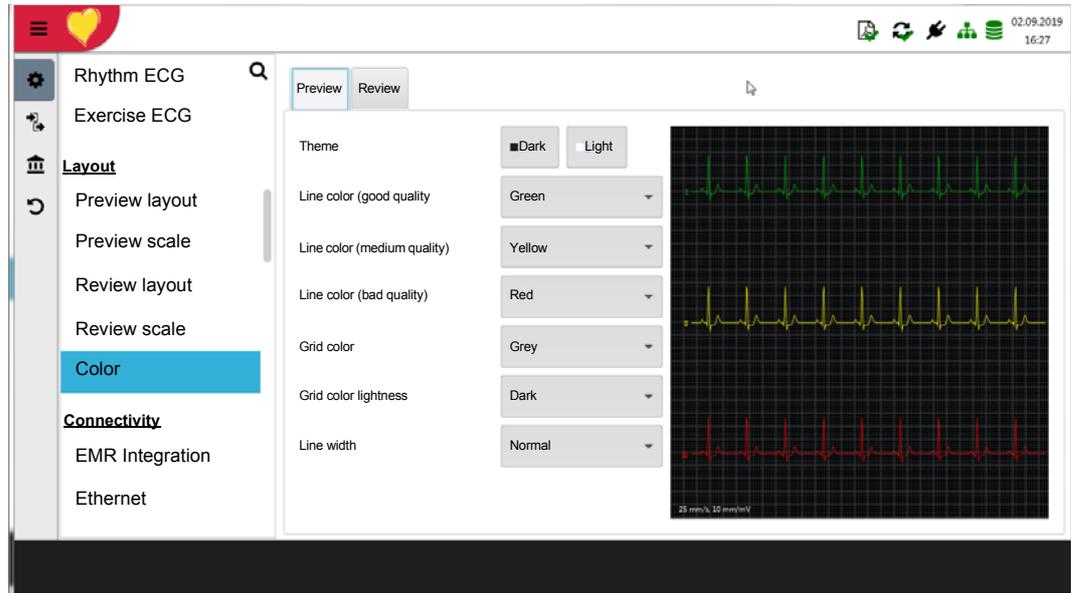
13.5   Connectivity

13.5.1   EMR Integration

Parameter	Description / Selection

EMR integration (Electronic Medical Record system)	• **None**
	• Schiller Link
	    – Device ID is displayed
	• Schiller Server
	    – Host, port, user and password input fields are displayed (see following)

Host	Name of the server, usually in the form for example, semaserver.stmaryshospital.com. - Note if the server is on the same hospital network, simple the server name can be entered, for example, SemaServer
Validate SSL Certificate	Checks if the SSL certificate of the server is signed by a trusted CA. (Secure Sockets Layer (SSL) certificates, sometimes called digital certificates, are used to establish an encrypted connection between a browser or user's computer and a server or website).
Port	Port address (usually 8181)
User	User name (for server)
Password	Password (for server)

Testing the Connection

When the **Test connection** button is clicked, the program pings the server to check connection. When connection is established, a message is displayed to that effect. An overview of the SCHILLER Server is given in the SCHILLER Server communication guide.

Connection succeeded ⓘ
Connection to SEMA Server succeeded
Ok

13.5.2   Ethernet

Parameter	Description / Selection
Use DHCP	**Yes**/No. If this is not activated, the following parameters need to be entered:
IP address	Identifier address of the device in the TCP/IP network
Subnet mask	Ex.: 255.255.255.0
Standard Gateway	Gateway IP address
DNS server	Domain name of the server

13.5.3   WLAN

General

Parameter	Description / Selection
WiFi enabled	Check to enable WiFi
SSID	• Select or enter the SSID (network service set identifier) of the network • Hidden: checkbox – Note: The Router for the WLAN can be configured to have a "visible" SSID, but it can also run hidden. In this case the router will not broadcast its SSID and devices cannot discover the SSID. This is a basic security feature. A user has then to find out the SSID of the router in order to know where to connect to. Therefore if AT-180 wants to connect to a router with hidden SSID you need to mark this checkbox.
WiFi security	• None • WEP • **WPA/WPA2 personal** • WPA2 enterprise
Encryption	• **AES** • TKIP
Password	Enter the password to connect with the network

Network

As above for Ethernet.

13.6   Regional

13.6.1   Date and Time

Parameter	Description / selection
Date format	• **dd.MM.yyyy** • yy-MM-dd • MM/dd/yyyy)
Time format	• **HH:mm:ss** • h:mm:ss
Time Zone	Date and time settings. Note that if the device is connected to SCHILLER server or SCHILLER-Link and EPA is set, manual time settings are disabled.
Key Sync time with server.	Time and date on the device are updated. The device needs to be restarted. This function is only possible when EPA integration has been set on SCHILLER-Link or SCHILLER Server.

13.6.2   Language

Define system language. The device must be restarted for the language to take effect.

13.6.3   Units

Parameter	Description / selection
Weight	• **kg** • g • lb
Length	• **cm** • m • inch
Speed	• **km/h** • mph
Temperature	• **ºC** • ºF (Fahrenheit)

13.6.4   Patient ID System

Parameter	Description / selection
Selection of the patient ID system used	• **None** • Swedish • Danish • Finnish • Norwegian

13.7 General

13.7.1 Info

Parameter	Description / selection
Info	• Device software and hardware versions are displayed.
Write info to USB	• A diagnostic file is written to the connected USB memory stick - for service person-nel only. Only available when a USB memory device is attached to the device)

13.7.2 Lock

i The Lock setting is only applicable (and only displayed) when the device is **password protected**, (that is, when **Access control** (below) is defined as **Basic** Device login active, **Local** or **SCHILLER server**).

Parameter	Description / selection
Lock Enabled	**Enabled** (checked) / disabled. When enabled, the user is logged out after a defined times and must log in again to access the application
Lock timeout [s]	When lock is enabled, define the lock timeout (seconds)

13.7.3 Power Management

Two separate power saving settings are available for when the device is working on battery supply and for when the device is connected to the mains supply.

Battery

Parameter	Description / selection
Dim backlight Active	**Enabled** (checked) / disabled. Dims the screen after a defined time
Dim backlight [s]	120 seconds (default).
Shutdown device active	**Enabled** (checked) / disabled. Closes the application after a defined time
Shut down device [s]	600 seconds (default)

Plugged in

Parameter	Description / selection
Dim backlight active	Enabled / **disabled** (unchecked). Dims the screen after a defined time
Dim backlight [s]	set duration to dim backlight when Dim backlight active.
Shutdown device active	**Enabled** (checked) / disabled. Closes the application after a defined time
Shut down device [s]	3600 seconds (default)

13.7.4   Access Control Mode

Parameter	Description / selection
None (default)	No login dialogue displayed at switch-on
Basic	• Device Login active - check and define the password. The application is password-protected. • Setting login active - check and define the password. The Settings menu is password-protected.
Local	Define local users. Every user is assigned to a role; each role has defined privileges **Users** Add users with: – User name – Password – Role **Role** Define the privileges for each of the three available roles: – Administrator – Nurse – Physician **Notes:** Users are created selecting the + icon. (Three users are pre-defined in the system, these are Administrator, Nurse and Physician (same as user roles)). All user names, passwords and the assigned role can be modified by selecting the edit icon. The privileges assigned for each of the threes roles can be modified by selecting the edit icon. The privileges that can be granted to each role are Adjust system settings, access memory, create recordings, edit recordings, validate interpretation. The characters that can be used for the user name are limited as follows: – Letters A to Z (normal or capitalized) – Numbers 0 to 9 – Special characters: hyphen (-), underline (_), dot(.)
SCHILLER Server	Log in with the user name and password (and corresponding role and privileges) defined by the SCHILLER server.

i   When Local is defined, only locally defined users can log-in. When SCHILLER Server is defined, only users that are defined by the server can log-in.

13.7.5   Station

Parameter	Description / selection
Device ID	Device identification
Institute	Name of the institute
Department	Name of the department
Network host name	Name of the network host

13.7.6   Mandatory Fields

Parameter	Description / selection
Resting and Rhythm ECG	Select fields that must be included in the patient data before an ECG recording is made. Different data can be defined for resting, exercise and signal average ECG recording. They include PatID, name, date of birth, gender, referring physician, etc. If a resting recording is attempted without these fields a message is given detailing the missing field(s) that need to be entered:

Patient data incomplete

Patient data missing:
Patient ID
Last name
Date of birth
Start recording anyway?

Yes   No

Parameter	Description / selection
Exercise ECG	As for resting above. Note that: – Date of birth – Weight – Height are already checked and are always mandatory for exercise recordings.
Signal Average ECG	As for Resting

13.7.7   Update

This function is to update the software of the unit using the SCHILLER update server (SUS) or software installed on a USB memory. Full details are provided in the CARDIOVIT AT-180 service handbook.

Parameter	Description / selection
Host	Define the update server address name (usually in the form for example, semaupdateserver.stmaryshospital.com)
Port	usually 8080
Check USB device for update file	The Update is performed via the connected USB stick.
Check Server for update file	Check Schiller Update Server to update software The check is performed on the Schiller update server. Therefore, an Ethernet/WLAN connection is required, including the necessary network settings for this connection

When a Program Update is Detected

When Update is clicked, the program is downloaded from the SUS or USB memory When the program has been downloaded you are prompted to install.

The program closes and the update starts. You are prompted to confirm and a progress bar is displayed..

i   Further details of the SUS are provided in the SUS configuration Guide (2.540096)

13.7.8   Manage Licenses

Parameter	Description / selection
Available options	AT-180 available options are shown. Enabled options are indicated by a tick next to the option.
Activate license	Enter the licence key and activate
Import licence from USB	Activation via USB stick (.lic file)

13.7.9   Workflow

Parameter	Description / selection
Transmit after save	Yes, **No**. ECG data is transmitted after acquisition and storage of the recording
PDF to USB after save	Yes, **No**. After saving, the PDF is transmitted automatically to the USB stick
Delete after export	**Yes,** No. PDF and recording are deleted from the memory once it has been exported/ transmitted to the USB stick/server.
Print after save	**Yes,** No. ECG data is printed once it has been stored.
PDQ mode	• None • **PDQ by Patient ID** • PDQ by Visit ID
Default workflow	Select the first view: • Worklist • **Recorder**
Cleanup local recordings	Check to delete all recordings older than the defined number of days. **All recordings are deleted, even if not sent to an EMR system.**

13.7.10   Printer

Parameter	Description / selection
Contrast	1-10 **(5)**
Line width	• Thin • **Normal** • thick

13.8   Rhythm ECG

13.8.1   General

Parameter	Description / selection
Rhythm Length	Define the default length for rhythm recordings (30 seconds to 20 minutes).
Show recording time dialog	Display the duration dialog before a recording is made

13.8.2 Events

Parameter	Description / selection
Manual Events	Define the wording for manual events. As many entries as required can be added separated by a carriage return (that is new line). Each line is handled as a single event entry and is available when a manual event is added to a rhythm recording. The event entry is available during the recording when the Manual event button is clicked (see para. 6.2.1, Manual Events, page 64).

13.9 Exercise ECG

13.9.1 General

Parameter	Description / selection

Target HR	• **WHO formula**:
	  – 220 – patient age
	• AHA formula:
	  – Patient age < 25: → 160
	  – Patient age > 75: → 115
	  – Otherwise: → 160 – (patient age – 25) * 0.9

J-point default	J10 to J100 (**J60**)
Step timer	Show: • **Remaining time** • Elapsed time

Recovery	This determines the action and icon to end the test as follows:
	
	• **Direct**
	  – the recovery phase is entered directly when end test is selected
	• Initialise
	  – the current exercise stage is completed before recovery stage is entered (set by user).

HR x BP units	• **mmHg/min (1/100)** • mmHg/min
Show chart legend	Display trends chart legend
Max. load calculation	• **Max step load** (max load achieved in the stage) • Time (the load, x seconds into the stage - see below) • Interpolated (interpolated load at stage end)
after seconds	Active when **Time** (Max. load calculation above,) is set (default **40 seconds**)

13.9.2   Actions

The action settings allows icons to be given in the side bar of an exercise test for entry of the following:

Parameter	Description / selection
RPE	check to display icon for RPE entry dialogue
Manual Event	check to display icon for Manual event entry dialogue
Lactate	check to display icon for Lactate entry dialogue
Toggle automatic NIBP and alerts for manual NIBP	check to display icon to enable/disable auto NIBP entry (when defined in the protocol (see para. 13.9.7, Protocol Editor, page 136)).

13.9.3   Averages

Parameter	Description / selection
show average complex	check as required
Show Isoelectric line (on average complex)	check as required
Show reference curve (on average complex)	check as required

13.9.4   Templates

Parameter	Description / selection
Template	Interpretation templates can be created with defined text and acronyms.

Click the **+ button** to define a new template:

New template   **+**

Template name   Irregular meas.

Save   Cancel
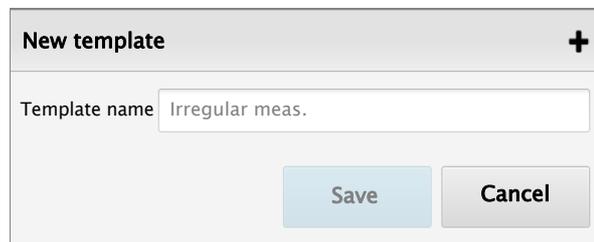
When defined, the template name appears in the interpretation screen and when selected, the defined template text appears in the interpretation screen (see para. 9.1.7, Interpretation, page 85).

13.9.5   Ergo Devices

Parameter	Description / selection
Ergo Device	• **Bicycle** • Treadmill
Bike Model	• ErgoSana • Ergoline • **Unsupported** - if the bike is not listed, select unsupported.
Treadmill Model	• MTM-1500 (Trackmaster) • MTM-1400 (Trackmaster) • Intertrack • Trackmaster 428 • **Unsupported** - if the treadmill is not listed, select unsupported.
Treadmill Speed unit	• **Km/h** • mph
NIBP Device	• **None** • Ergo Device • BP-200 plus
Enable Sp02 Trend	Check this box to use the Sp02 measurement from the NIBP device. Note that this option is only displayed when Ergo device or BP-200 plus is selected for the NIBP Device above.

13.9.6   Protocols

Parameter	Description / selection
Ergo device	• Bicycle • Treadmill
Protocol	Select the protocols from the list that will be available when an exercise test is entered. The protocol on the top of the list will be the default (note that when an exercise test has started the protocol cannot be changed).

13.9.7   Protocol Editor

Parameter	Description / selection
Ergo device	• Bicycle • Treadmill
Protocol Name	
Ramp	Check to make a ramp protocol (load increased gradually over the stage)
Warmup step	Check to include a warmup step in the protocol

Bike and Treadmill protocols can be defined and viewed for selection in Protocols at the start of the test.
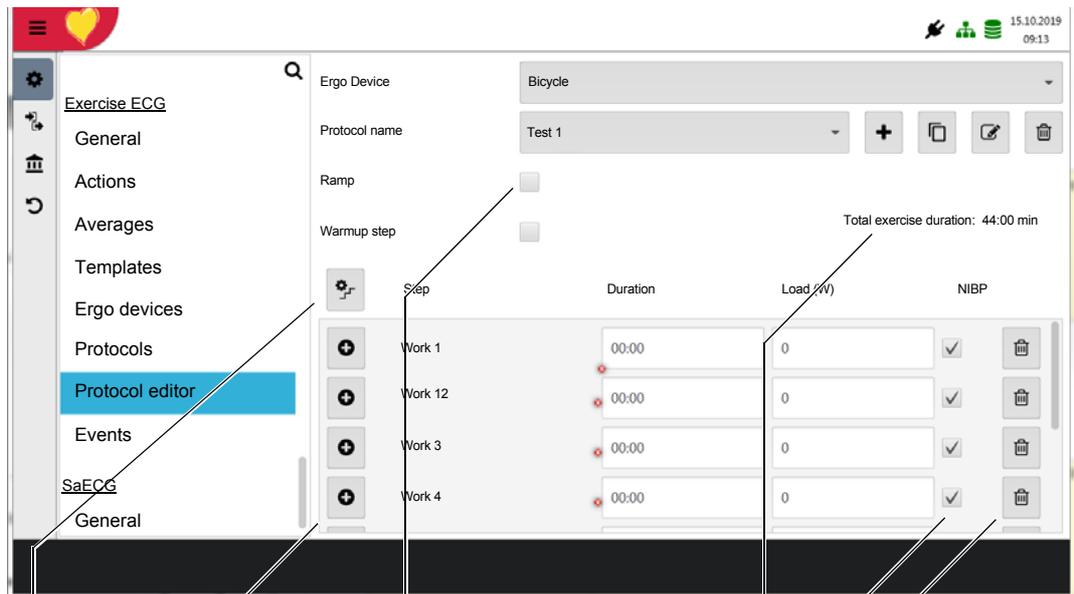
Add step

Check to define Ramp protocol (load is evenly applied over the stage)

Remove step

Check to take a BP measurement during the stage (see note)

Total work time displayed as stages edited

Select this icon to create a protocol with n steps with same load and duration. The following dialogue is displayed:

Ramp Protocol: When the Ramp checkbox is ticked (see above), the icon changes to indicate a ramp protocol ⚙. The number of steps is not visible. and the load increase and duration can be set.
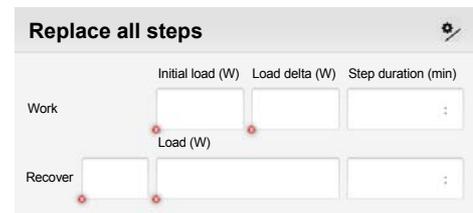
Defining a New Protocol

1. Select the ergo device (bike or treadmill).
2. Select the protocol on which the new protocol can be based (or a new one)
3. Click the '+' icon.
4. Define the new protocol name.
5. Check the ramp box for a ramp protocol (step increase is carried out over the step and not a 'step increase').
6. Check the warmup step to define a warmup stage.
7. For each step check the BP box to initiate a BP measurement for that stage or display the BP input screen for manual entry.

Note:
- A BP measurement is taken 10s after the pre phase, (when a warmup phase is defined)
- A BP measurement is initiated when checked for a stage, as follows:
- 50s before the end of work/recovery step OR
- instantly if work/recovery stage duration is less than 50s.

8. Define work and recovery stages load or elevation / speed.

The procedure described here is for a bicycle protocol. The protocol editor for a treadmill is similar but with speed/elevation instead of load.

13.9.8   Events

Parameter	Description / selection
Manual Events	Define the wording for manual events. As many entries as required can be added separated by a carriage return (that is new line). Each line is handled as a single event entry is available during the recording when the Manual event button is clicked. (see para. 8.5.10, Events, page 80).

13.10   Signal Average ECG

Parameter	Description / selection
Max. number of beat counts	The maximum number of beats accepted. Select between: • Off • 50 • **100** • 200 • 500 • 1000
Correlation	This is the percentage that a QRS complex must be similar to the reference complex to be accepted. Select between: • 98% • **98.5%** • 99% • 99.5%
Max. Noise	• The desired target noise on the vector magnitude in the ST segment: • Off • **0.3 µV** • 0.5 µV • 0.7 µV • 1.0 µV
Master lead/slope	• select between X, Y or Z, leading or trailing edge (+, -), or automatic. When automatic is defined the program assesses the best trigger point. • **Automatic** • X- • Y- • Y+ • Z- • Z+
Filter	• 40 Hz • 25 Hz

14 Cleaning and Disinfecting

⚠WARNING	▲ Switch off the device before cleaning and disconnect from the mains by removing the plug.

⚠ CAUTION	▲ Do not, under any circumstances, immerse the apparatus into a cleaning liquid or sterilise with hot water, steam, or air.
	▲ Do not autoclave the device or any accessories.
	▲ Use of cleaning solutions which have a high acid content or are otherwise inappropriate can cause damage to the equipment, including cracking and deterioration of the plastic case.
	▲ Always follow the usage instructions provided by the manufacturer of the cleaning solution.
	▲ With time, the casing may become less resistant:
	  – if an alkaline cleaner or a cleaner with a high alcohol concentration is left for a long time on the surface, or
	  – if a warm disinfectant or detergent is used. Schiller AG therefore recommends using only cleaning agents that are adequate for sensitive materials such as plastics, and using them at room temperature (approx. 20°C).
	▲ Never use any of the following solutions or similar products to clean the equipment: Ethyl alcohol, acetone, hexane, abrasive or scouring powder or material, any cleaning material that damages plastic.
	▲ Device connectors, and battery and electrode cable contacts, must not come in contact with soap or water. Do not immerse in liquid when cleaning. Do not spray the device directly. Only clean the device and cable with a damp cloth **slightly moistened (not wet)** on the surface only. If liquid does penetrate the device, switch it off immediately and send it to SCHILLER for testing
	▲ The patient cable and other cable assemblies must not be exposed to excessive mechanical stress. Whenever disconnecting the leads, hold the plugs and not the cables. Store the leads in such a way as to prevent anyone stumbling over them or any damage being caused by the wheels of instrument trolleys.
	▲ When cleaning, ensure that all labels and safety statements, whether etched, printed or stuck to the device, remain in place and remain readable
	▲ The wearing of protective gloves (e. g. of butyl rubber) during cleaning is recommended.

14.1 Cleaning Interval

It is recommended that the device is cleaned on a regular basis. Any visible soiling must be cleaned immediately.

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14.2   Before Cleaning

Before cleaning any cable assemblies, the device or any accessories, thoroughly inspect them for signs of damage as follows:

- Look for any signs of damage and any improper mechanical function of buttons or connectors.
- Gently bend and flex all parts of the patient cable. Inspect for splits in the sheathing, damage or extreme wear, exposed wires, or bent connectors.
- Confirm that all connectors engage securely.

14.3   Cleaning / Disinfecting Procedure

⚠ CAUTION

▲   Observe the following safety notes when cleaning/disinfecting the device.
  – Never immerse the device or patient cable in liquid
  – Never pour or spray liquid directly onto the patient cable
  – Make sure that no liquid penetrates the connections or openings
  – The device and / or patient cable must not be autoclaved or sterilised with steam

Before cleaning/disinfecting the unit thoroughly inspect for any signs of damage and any improper mechanical function of buttons or connectors. Switch off the device before cleaning.

▲   Do not spray the device directly.
▲   Make sure that no liquid penetrates the device.

▲   Clean the device with a damp cloth **slightly moistened (not wet)** on the surface only. Use cleaning agents that are mild and diluted with water that are suitable for PC polycarbonate - approved cleaning solutions are listed following,

Use a clean lint-free cloth moistened with detergent and wipe the unit to clean. Wipe off any excess cleaning solution. Leave to dry in the air for at least 30 minutes

Ensure liquid does not get into connectors. If liquid should get into connectors, dry the area with warm air, and then check the equipment to confirm that it operates properly.

Do not let the cleaning solution run into or accumulate in connector openings, latches, or crevices. If liquid penetrates the device or into the connectors this may interfere with correct functioning. Remove the patient cable and USB stick (if attached). Leave the device in a warm, dry room for 48 hours and then check the equipment to confirm that it operates properly. If the functioning is still affected, contact the manufacturer.

Ensure the contacts of the patient cable are completely dry before reassembling.

14.3.1   Cable Assemblies

1. Before cleaning, inspect the cable for damage as detailed above.

2. Wipe the equipment with a cloth slightly moistened (not wet) with one of the approved solutions listed below.

3. Gently grip the cable with the damp cloth in the centre of the cable and slide the cable through the cloth 20 cm at a time until clean. Do not clean the whole length in one single action as this may cause bunching of the insulation sheathing.

4. Wipe off any excess cleaning solution. Do not let the cleaning solution run into or accumulate in connector openings, latches, or crevices. If liquid gets into connectors, dry the area with warm air.
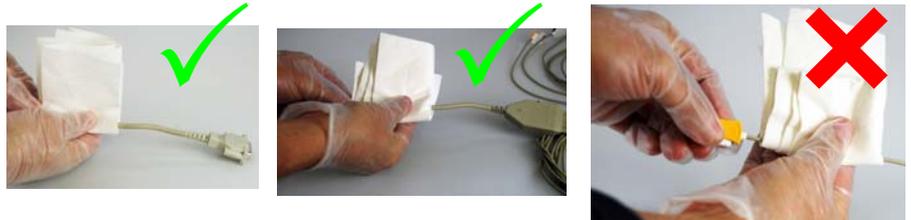
14.3.2   Keypad

The keypad silicon can be removed for replacement or cleaning.
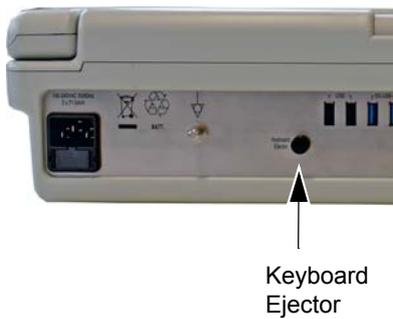
Keyboard
Ejector

To remove the keypad cover:

1. Pull the keyboard ejector button on the back panel to gain access to the keyboard
    –   This lifts the key from to the keyboard

2. Carefully remove the Silicon keyboard cover

3. Wipe the keypad cover with a cloth slightly moistened (not wet) with one of the approved solutions listed below.

4. Ensure the Keypad is fully dry before replacement and carefully replace.

▲ The keyboard is attached to the device housing by a cable inside the keyboard aperture. When removing and replacing the keyboard cover, ensure no strain is placed on the cable or plug of the keyboard.

▲ Ensure no cleaning solution or moisture enters the keyboard when removed

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14.4   Cleaning Solutions

14.4.1   Construction Material

Ensure that all cleaning material used on the CARDIOVIT AT-180 is suitable for the material used in its construction. The list of cleaning solutions and disinfectants are provided as a general guide. If in doubt about the suitability of a cleaning solution or disinfectant, check that the solution is suitable for the materials used in the construction of the CARDIOVIT AT-180.

AT-180 Section	Material
Housing (including monitor housing)	PC/ ABS (polycarbonate-ABS)
Keypad cover	Silicon
Monitor	Glass
Patient Cable	PE (Polyethylene)

14.4.2   Approved Cleaning Solutions

• 50% solution isopropyl (isopropanol) alcohol

• Neutral mild detergent solution

• All products designed for cleaning plastic.

14.4.3   Cleaning Materials that must not be used

Never use products containing the following:

• Ethyl alcohol

• Acetone

• Hexane

• Abrasive cleaning powder

• Plastic-dissolving products

i   Using these products or products containing similar components can cause discoloration of the product, corrosion and reduction of the product life, and may render the warranty invalid.

14.5   Disinfection

Disinfection removes certain bacteria and viruses. Please refer to the manufacturer's information. Use commercially available disinfectants intended for clinics, hospitals and practices to disinfect the device. Disinfect in the same way as described for cleaning (previous page).

14.5.1   Approved Disinfectants

• Isopropyl alcohol 50%

• Propanol (35%)

• Ethyl hexanal

• Aldehyde (2-4%)

• Ethanol (50%)

• all products that are suitable for PC/ABS plastic

14.5.2   Recommended

SCHILLER recommends the following for disinfecting the device:

• Bacillol® 30 Tissues

• Bacillol® 30 Foam

• mikrozid® liquid

• mikrozid® wipes

14.5.3   Non-admissible Disinfectants

Never use products containing the following:

• Organic solvents

• Ammonia-based detergent

• Abrasive cleaning agents

• 100% alcohol, Virex, Sani-Master

• Sani-Cloth, Ascepti or Clorox wipes

• HB Quat

• Conventional cleaner (e.g. Fantastic, Tilex, etc.)

• Conductive solution

• Solutions or products containing the following ingredients:
  – Acetone
  – Ammonium chloride
  – Betadine
  – Chlorine, wax or wax compound
  – Ketone
  – Sodium salt

14.6   Cleaning the Thermal Print Head

⚠WARNING	▲ Switch off the device before cleaning the print head and disconnect from the mains by removing the plug.

A residue of printers ink (from the grid on the paper) can build up on the print head over a period of time. This can cause the print quality to deteriorate. We recommend therefore that every two months or so (dependent on use) the print head is cleaned with alcohol as follows:

Extend the paper tray and remove paper. The thermal print-head is found under the paper tray. With a tissue dampened in alcohol, gently rub the print-head to remove the ink residue. If the print-head is badly soiled, the colour of the paper grid ink (i.e. red or green) will show on the tissue.

Paper replacement is detailed earlier in this book.

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15 Maintenance

15.1 Device Maintenance Schedule

i All maintenance work must be carried out by a qualified technician authorised by SCHILLER AG. Only maintenance procedures given in this book, for example, visual inspection, may be carried out by the user. The following table indicates the maintenance intervals, the maintenance requirement, and the person authorised to carry out the procedure.

Interval	Service	Responsible
Before each use	• Visual inspection of the device and ECG electrodes	➜ User
As Required (see previous section)	• Clean device and cable assemblies • Thermal print head clean	➜ User
Every 6 months	• Visual inspection of the device and cables • Functional, touch screen and keyboard check • Basic functional check	➜ User
Every 12 months or as defined by local regulations.	• Functional tests according to the Service Handbook • Recurrent test and test after repair according to IEC / EN62353	➜ Service staff authorised by SCHILLER AG
circa. every 3 - 5 years	• Replacement of battery after approx 300 charge discharge cycles or if running time is substantially reduced.	➜ Service staff authorised by SCHILLER AG

15.2 Visual Inspection

Visually inspect the device and cable assemblies for the following:

➜ **Device casing** - not broken or cracked.

➜ **Touch screen** - not broken or cracked.

➜ **Electrode cable, mains cables, and all cable assemblies** - sheathing and connectors undamaged. No kinks, abrasion or wear in any cable assembly.

➜ **Input/output connectors -** all pins and sockets undamaged, straight and no signs of excessive wear.

➜ Electrode packets and all other accessories within 'use by' date.

⚠ ▲ Do not use if the device, or any cable assembly or accessory, is damaged.

▲ Defective devices, damaged cables, or damaged accessories must be replaced immediately.

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15.3 Functional, Touch Screen and Keyboard Check

This procedure provides a basic software integrity check, checks that the touch screen is usable, and checks the keyboard. Proceed as follows:

1. Switch the device on.
   – Check the monitor - ensure the display is clear and readable. Look for missing pixels.
2. Open the patient data dialogue screen and enter some patient data.
   – Ensure correct entry of data.
3. Cancel the patient data entered.

15.4 Basic Functional Check

➜ Connect an ECG simulator to the device, switch on the CARDIOVIT AT-180 and enter the acquisition screen.
➜ Ensure the ECG trace is displayed
➜ Remove an electrode lead from the simulator
➜ Check the electrode hook up screen displays that the electrode is high resistance.

15.5 Safety and Functional Checks

▲ A recurrent test must be carried out every year or as defined by local regulations by a certified authority according to the CARDIOVIT AT-180 service handbook and Recurrent test and test after repair according to IEC / EN62353.

15.6 Tests After Defibrillation

Return the device to an authorised SCHILLER facility for Recurrent test and test after repair according to IEC / EN62353.

15.7   Changing the Mains Fuse

⚠ DANGER

▲   Before the fuse and mains voltage are changed, the device must be disconnected from the mains and the mains plug removed for the wall socket.

▲   The fuse may only be replaced by the fuse type the table below.

15.7.1   Fuse types

Voltage range	Number	Fuse type	Part No.	Manufacturer Part No.
100-240 VAC	2	T 1.6 AH	TBA	TBA

T = Slow blow

H= Enhanced breaking capacity

15.7.2   Changing the Fuse

1.   Release the fuse holder by gently inserting a blunt object into the holder groove and sliding the fuse holder away from the device.

2.   Replace both fuses. Re-insert the fuse holder until fully home.

15.8   Battery Maintenance

The battery is maintenance free during its normal life.

- No maintenance is necessary during normal operation.
- If the device is not used, check and recharge the battery every three months. The battery should not be allowed to fully discharge during storage.
- Replace the battery every 2 to 5 years (depending upon application when the running time falls substantially under four hours).

15.8.1   Recharging the Battery

It is possible to use the device when the battery is being charged, however the charging time of the battery will be extended. A totally discharged battery requires the following times to charge:

- Approximately 80% capacity (from fully depleted) - 4 hours

1. Connect the device to the mains but do not switch it on.
2. The LEDs for both mains and battery are illuminated.
3. The battery LED is extinguished when the battery is fully charged.

15.8.2   Battery Disposal

At the end of the battery's life, do not dispose in household waste. Batteries must be disposed of in a municipally approved collection point or recycling centre.

⚠ **CAUTION**

- ▲ Explosion warning. The battery must not be burned or disposed of in domestic trash.
- ▲ Flammability and chemical danger. Do not open the battery. Do not disassemble, mutilate, incinerate, or heat. Do not short circuit a battery. May cause burns.
- ▲ Protect the contacts from shorting when disposing of the battery. Apply non-conducting tape to the contacts.

15.9   Decommissioning

Please observe the following points concerning the decommissioning and storage of the equipment:

- Backup all program data
- Disconnect all couplings and connections
- Clean all devices and components and disinfect them if necessary
- Correctly pack and, if applicable, correctly mark/label each individual component
- Observe the environmental conditions for storage and transportation

15.10   Disposal

15.10.1   Electronic Parts

At the end of the life cycle, the device and accessories must be disposed of in accordance with the applicable international and national waste control regulations for electronic components. Parts must be collected separately from ordinary unsorted municipal waste when marked with the label for separate collection of electronic and electric waste.

Please contact SCHILLER if you have any questions concerning the disposal of your equipment.

15.10.2   Consumables

Consumables must be disposed of in compliance with national and international rules and regulations.

Contamination Risk

– Depending on their classification consumables may be disposed as domestic waste or clinical waste.

⚠ CAUTION

▲ Consumables may be contaminated. The operator / customer is obliged to establish a quality management system for the handling of contaminated waste.
▲ The pertinent risk analysis must include the accessories and consumables, especially the disposables intended for single use.

15.11   Adding Options

– All software options are embedded in the system and are activated by a code supplied by SCHILLER. The procedure to activate the options are given in the Settings section.

15.12 Inspection Report

This page can be copied and used as a device maintenance reference sheet.

15.12.1 Every Six Months

Inspection																							
Visual Inspection page 144																						
➜ Device casing - not broken or cracked.	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏
➜ Touch screen - not broken or cracked.	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏
➜ Electrode cable, mains cables, and all cable assemblies - sheathing and connectors undamaged. No kinks, abrasion or wear in any cable assembly.	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏
➜ Input/output connectors - all pins and sockets undamaged, straight and no signs of excessive wear.	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏
Basic Functional Check page 145																						
➜ Ensure the ECG trace is displayed	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏
➜ Check the electrode hook up screen displays that the electrode is high resistance.	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏
Date Of Inspection and Inspector:																						

15.12.2 Every 12 Months

Inspection	Results													
Safety and Functional Checks page 145 ➜ Confirm the date of the factory inspections and test.	• If the device is due for the factory inspections and tests (every 12 months or according to local regulations), return the device to your nearest authorised SCHILLER agent.	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏	❏
	Date of Inspection and Inspector													

15.13   Trouble Shooting

The following table gives possible fault conditions, causes and possible remedies. A list of system messages, error messages, and fault messages is given on the following pages.

Fault	Possible Causes and indicators	Remedies
Device does not switch on, blank screen.	• No mains supply, Green mains indicator off. • Mains supply ok, but the screen is still not lit.	➔ Check mains supply, check fuses. ➔ If mains indicator is lit it indicates that power is reaching the device and the internal power supply should be Ok. Press and hold the On/Off key for 5 seconds. Wait a few seconds and switch on again. ➔ If the screen is still not lit it indicates a software fault, monitor problem or internal power supply. Call your local SCHILLER representative.
ECG trace is not displayed or stops after being displayed.	• ECG amplifier hangup, power interruption or power surge.	➔ Switch off the device and restart.
Functional or display icons not displayed.	• Icons not enabled in System Settings.	➔ Check that the options have been enabled in System Settings.
Required lead configuration not available	• Lead configuration not enabled in System Settings.	➔ Check that the fields have been enabled in System Settings.
No export after test, incorrect screen displayed after test, No Printout after test, etc.	• Settings incorrect, not enabled.	➔ Check Settings (Workflow)
No Stage printout during an exercise test, no printout after a test, no automatic BP Measurement, Position stages used / not used, cannot select ergometer, etc.	• Exercise Settings incorrect.	➔ Check exercise settings.
QRS traces overlap.	• Incorrect settings for Patient. • Bad electrode contact.	➔ Change sensitivity setting. ➔ Check electrode contact. Replace electrodes. ➔ If traces still overlap: Call your local SCHILLER representative. ➔ Note: Some patients have very high amplitudes and even on the lowest sensitivity settings, the QRS traces can overlap.
'Noisy' traces	• High resistance electrode contact. • Patient not relaxed. • Incorrect filter settings.	➔ Check electrode contact. Resistance readings should be ± 200mV. ➔ Re-apply electrodes. ➔ Ensure that the patient is relaxed and warm. ➔ Check all filter settings ➔ Activate filter ➔ Ensure mains filter is correct for mains supply. ➔ If the trace is still noisy call your local SCHILLER representative.

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Fault	Possible Causes and indicators	Remedies
No printout obtained after an auto mode recording.	• No paper / Paper incorrectly loaded.	➜ Ensure that paper is loaded correctly.
	• Incorrect settings.	➜ Check Settings - ensure that a printer is selected and that enable direct print is set in the ECG settings. Check all printer settings. If the printer still doesn't work: Call your local SCHILLER representative.
Internal Thermal Printout quality - Printout fades, is not clear, or the printout is 'patchy'.	• Old paper inserted.	➜ Ensure that fresh SCHILLER paper is installed.
		➜ Ensure that the paper has been installed correctly with the paper mark at the top.
		➜ Note that the thermal paper used for the CARDIOVIT AT-180 is heat and light sensitive. If it is not stored in its original seal, stored in high temperatures or is simply old, print quality can deteriorate.
	• Dirty print head.	➜ Over a period of time, the printing ink from the grid on the paper can form a film on the thermal print head. Clean the thermal print head.
	• Print-head out of adjustment.	➜ The printhead tension must be adjusted according to the CARDIOVIT AT-180 service handbook - call your local SCHILLER representative.
No printout of interpretation statement average cycles or measurements	• Incorrect setting.	➜ Check that the interpretation and measurement options are enabled for the printout. Check all printer settings.
No key response, LCD locked	• Software hangs up.	➜ Press the on/off key for 4 seconds to force shutdown. Switch on again after a few seconds.
		➜ If the device is still not working call your local SCHILLER representative.

15.14   Error Messages

Error messages can be displayed when an error is detected. Error messages are self explanatory and associated with the actions that the user was doing.

System error messages are written to a system log file that is detailed in the service handbook.

16 Accessories and Disposables

⚠WARNING	▲ Always use SCHILLER replacement parts, cables, electrodes and disposables, or products approved by SCHILLER. Failure to do so may endanger life and invalidate the guarantee.
	▲ Always use medical grade mains cable and power supply.

Your local representative stocks all the disposables and accessories available for the CARDIOVIT AT-180. A full list of all SCHILLER representatives can be found on the SCHILLER website (www.schiller.ch). In case of difficulty contact our head office.

16.1 Patient Cables and Electrodes

Article no.	Article description
2.400180	10-wire patient cable IEC 2m, banana plug type
2.400175	10-wire patient cable IEC, 3.5m clip-type
2.400179	10-wire patient cable AHA 2m, banana plug type
2.400178	10-wire patient cable, clip type, 3.5m, AHA
2.400139	14-wire patient cable AHA, for 16-lead acquisition, clip type, 3.5m, with detachable single leads, C1 to C6, N, R, L, F and A1 to A4
2.400140	14-wire patient cable IEC, for 16-lead acquisition, clip type, 3.5m with following detachable single leads, C1 to C6, N, R, L, F and A1 to A4
2.400141	14-wire patient cable AHA, for 16-lead acquisition, banana plug, 3.5m, with detachable following single leads, C1 to C6, N, R, L, F and A1 to A4
2.400142	14-wire patient cable IEC, for 16-lead acquisition, banana plug, 3.5m, with following detachable single leads, C1 to C6, N, R, L, F and A1 to A4
2.410090	Detachable single wires banana plug type, Balanced Set 4 pcs (C3r, C4r, C8, C9) for patient cable 2.400142, 2.400141
2.410099	Detachable single wires clip type, Balanced Set 4 pcs (C3r, C4r, C8, C9) for patient cable 2.400140, 2.400139
2.000041	Set of adult ECG electrodes incl. 6 suction electrodes, 4 clamp extremity electrodes and 1 ECG electrode gel 50ml
2.000052	Set of children ECG electrodes incl. 6 suction electrodes, 4 clamp extremity electrodes and 1 ECG electrode gel 50ml
2.155000	Suction electrode 4mm
2.155020	Adult clamp extremity electrode, set of 4
2.155025	Blue Sensor Disposable ECG Electrode, ø 48mm, Set of 25
2.155030	Abrasive pads CARDIO-PREPS, pouch of 50
2.155031	SCHILLER Biotabs Ag/AgC, disposable electrodes for resting ECG, box of 500
2.155032	SNAP-CLIP Adapter for banana-plug cables pouch of 10
2.155060	Replacement bulb for suction electrode 2.155000
2.158000	Electrode gel 50 ml
2.158006	ECG electrode contact spray, bottle 250 ml
2.410041	Adapter for snap-on fastener, set of 10

Art. no.: 2.511360 Rev. a

16.2 Thermal Printer Paper

Article no.	Article description
2.157039	Thermal chart paper - thermosensitive, Z-folded, 1 package, 210 mm wide, minimum order 10 packs

16.3 Trolley

Article no.	Article description
2.101169	Trolley X3 incl. basket for AT-180
2.101118	Drawer for trolleys X1, X2, X3, X4
2.101119	Basket translucent for trolleys X1, X2, X3, X4
2.101120	Shelf 45x38cm for trolley X2, X3, X4
2.101121	Holder Barcode scanner for trolleys X1, X2, X3, X4
2.101130	ECG cable support for trolley X1, X3
2.101170	Mouse tray kit for trolley X3
tba	BP-200plus holder kit for trolley X3
tba	14-wire patient cable holder for trolley X1, X3

16.4 Mains and Ground Cables

Article no.	Article description
2.300003	Mains cable AC Swiss, 90° angled
2.300004	Mains cable UK, 90° angled
2.300005	Mains cable Schuko Europe 2,5m, 90° angled
2.300024	Mains cable USA hospital grade, 2,5m, 90° angled
2.300014	Mains cable, China, 90° angled
2.300016	Mains cable, Japan, 90° angled
2.300025	Mains cable Brazil, 90° angled
2.300015	IEC device connecting cable 1,5m
2.300026	IEC socket board with 2m cable for IEC ECG device connecting cable 2.300015
2.310005	Ground cable with 6mm MC plug

16.5 Accessories

Article no.	Article description
2.000147	Laser Barcode Scanner Set incl. short instructions
2.100236	PC mouse USB
2.200215	ECG Simulator with addition for Wilson derivations Phantom 320 English (AHA colours)
2.200216	ECG-Simulator Phantom 320, German (IEC colours)
2.200241	ECG Simulator MS410
2.100060	Ergo-belt WSP 80
2.156039	Replacement pouch for ergo-belt 2.100060
4.520564	QRS Trigger cable BP-200 plus

17 Technical Specification

17.1   System

Dimensions	
LCD closed	• 465 mm (width) x 315 mm (depth) x 115 mm (height) mm (18.3 x 12.4 x 4.5 in)
LCD open	• 465 x 315 x 405 mm (18.3 x 12.4 x 15.9 in)
Weight	• approx. 11.5 kg
Power Supply	Mains or battery operation
Mains voltage	• 100 - 240 VAC (nominal), 50 or 60 Hz
Power consumption	• 100 VA Maximum
Power consumption normal operation	• 75 VA (ECG acquiring, no printout)
Fuse rating	• 2 x 1.6 AT H
Battery	
Type	• Two battery packs, 11.25 V, 8850 mAh, Li-Ion rechargeable (internal charger)
Capacity	• 4 hours with ECG printout every 15 minutes
Life	• more than 300 cycles with min 80% initial capacity
Charging time	• 4 hours to approximately 80% charge (from fully depleted)
Operating System and Memory	
Operating system	• Linux
Memory	• Min. 10 GB data storage for ECG recordings
Monitor	
Display type	• LCD with PCAP, 16.7 M display colours
Resolution	• 1366x768
Size	• 18.5''
Displayed leads	• 3, 6, 12 or 16 (optional)
Sensitivity	• 5,10 or 20 mm/mV
ECG Speed	• 12.5, 25 or 50 mm/s
Review ECG	• Review speed: 12.5/25/50 mm/s
	• Review amplitude: 5/10/20 mm/mV
Printer	• Integrated high-resolution thermal printer, thermal dot array (real-time print)
Thermal paper format	• Z-fold BPA-free thermal paper (210x280 mm) with paper maker on top
Number of simultaneous leads	• Up to 16
Writer Leads	• 3, 6, 12, or 16 leads
Paper speed manual printout	• 5/ 12.5/ 25/ 50 mm/second
Sensitivity manual printout	• 5/ 10/ 20 mV/mm
Resolution	• 8 dots/mm / 200 dots/in (amplitude axis), 40 dots/mm / 1000 dots/in (time axis), @25 mm/s
Keyboard	Sealed silicon alphanumeric keyboard
Direct Keys	• 3 (Auto ECG, Start manual print, Stop manual print)
Audible Noise Output	
Full operation	• <43 dB (measuring distance 1 m, max noise during printout)
Standby mode	• No audible noise

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17.2   ECG

Recording Functions

Number of simultaneous leads	• 12 lead simultaneous analysis / optional 16 lead simultaneous analysis
Review	• On screen review of ECG
Quality check	• Signal quality check and lead reversal detection
ECG amplifier saturation	• When input signal amplitude is higher than approximately ± 600 mV, a Lead-Off is indicated.
Lead sequence	• Standard, Cabrera
Lead configurations (10 wire cable)	• Standard 12 lead, Pediatric, Right precordial, Standard C4r, left posterior, Nehb, Balanced 12 lead, Frank XYZ bipolar, Frank XYZ Orthogonal
Lead configurations (14 wire cable)	• Standard 12 + Balanced, Standard 12 + Right Precordial Full
Resting ECG	• Provides 10 seconds of instantaneous ECG acquisition
	• Computerised measurements
Resting rhythm	• Recording up to 20 minutes
Create Resting ECG from a Rhythm recording	• Create a 10 second resting ECG from (a segment of) a resting rhythm recording
SAECG	• Signal Averaging ECG
Exercise ECG	• Bazett, Fredericia, Framingham or Hodges
QT formula	
ECG Amplifier	• Active, Type CF floating isolated powered 14 channel acquisition module with built-in lead-fail detection and lead preparation impedance measurement.
	• Complies with IEC standard 60601-2-25 and ANS/I/AAMI EC11

17.3   Filters

Myogram Filter	• Low Pass 25, 40, 150 Hz or off (350 Hz)
AC Filter	• 50 Hz or 60 Hz
Exercise Display Filter RNSF	• Reduces noise and baseline artefacts to suppress or greatly reduce baseline fluctuations without influencing the measurement values.

17.4   Interfaces

USB 2 connectors (x2) and USB 3 connectors (x2)	For connection of external USB devices, for example:
	• Memory stick
	• Mouse
	• Barcode Reader
PDF Export	PDF /A-1a or b to an attached USB Memory Stick
RS-232 connectors (COM 1, COM 2)	Connection of (for example)
	• COM 1: Treadmill, Ergometer
	• COM 2: BP device, e.g. BP-200 plus

Other Connectors

RJ45	• Network connector for LAN (Ethernet 1 Gbit)
Signal Out	• This connector is used for QRS trigger output signal.

    – Socket 6, QRS out, 5 V level
    – Socket 5, Ground
    – Output Impedance: ≤100 Ω
    – When the SCHILLER BP-200plus blood pressure device is connected, use cable assembly Art. No. 4.520564 for the QRS trigger. The trigger settings for the BP-200plus are defined in system settings

17.5   Environmental

Environmental conditions (operating)

Temperature	• + 10 °C to + 40 °C
Relative humidity	• 15 to 95 % (non-condensing)
Pressure	• 700 to 1060 hPa

Environmental conditions (storage and transport)

Temperature transport	• - 10 °C to + 50 °C
Temperature storage	• + 5 °C to + 50 °C
Relative humidity (storage and transport)	• 10 to 95 % (non-condensing)
Pressure (storage and transport)	• 500 to 1060 hPa

Disposal

Electrical and electronic equipment.	• Equipment/components and accessories no longer required must be disposed of in a municipally approved collection point or recycling centre. Alternatively, you can return the equipment to your supplier or SCHILLER AG for disposal. Improper disposal can harm the environment and human health.

17.6   Standards

Safety standard

Conforms with:	• IEC/EN 60601-1
	• IEC/EN 60601-1-25

Software Safety Class according IEC 62304

B

Notified Body

CE123 (TÜV Süd)

EMC

Conforms with:	IEC/EN 60601-1-2

Classification (IEC 60601-1)

Protection Applied Part	CF
Protection Device	Class I (with internal power supply)

Conformity/classification

CE/IIa in accordance with directive 93/42/EEC

Protection IEC 60529

This device is not designed for outdoor use (IP 20)

17.7   WLAN standards

Modules	WL1837MOD
FCC ID **IC ID**	Z64-WL180DBMOD 451I-WL18DBMOD
Transmission standards	IEEE 802.11 a, b, g, n
Security Protocol	WPA2 Enterprise / ieee802.1, WPA2-PSK, WPA-PSK, WEP64/128PSK, Encryption: AES and TKIP
Frequency range	Dual-band 2.4 GHz and 5 GHz
Max. power output 2.4 GHz (1DSSS)	+16.5 dBm
Max. power output 5 GHz (OFDM6)	+18 dBm

17.8   Options

Hardware	• Keyboard silicon cover (different layouts available) • Device Trolley
Software	
ECG interpretation algorithm	• Assists the user in the evaluation of the ECG, providing various measurements derived from the ECG and interpretation statements
ETM sport (included in ETM)	• Assists the user in the evaluation of ECGs in athletes, providing various interpretation statements based on the Seattle Criteria.
ECG re-measurement	• Allows the user to modify measurement points by means of callipers.
Exercise test	• ECG acquisition during exercise performed on a treadmill or bike. The device provides continues ST information for the diagnosis of acute cardiac syndromes.
Arrhythmia detection	• Detects arrhythmias (VES) during exercise tests and resting rhythm acquisition.
Signal averaging ECG (SAECG)	• Assists the user in the risk assessment/stratification of ventricular arrhythmia.
16-lead ECG	• Increase the chances to detect posterior and left myocardial infraction with 4 additional electrodes.
Vector ECG	• Provides a 3-dimensional view on the electrical activity, and adds value to the diagnostic of the hearts backside.
Communication	
SCHILLER Server	• PDF export to HIS/EMR • DICOM/HL7 ECG export to HIS/PACS • HIS/EMR patient import for PDQ or Worklist • HIS / EMR Results Export
SCHILLER Link	• PDF export to EMR • Patient data import

17.9   Preventing Electromagnetic Interferences

"Non-ionising electromagnetic radiation"

The user can help avoid electromagnetic disturbances by keeping the minimum distance between portable and mobile HF telecommunication devices (transmitters) and the CARDIOVIT AT-180. The distance depends on the output performance of the communication device, as indicated below.

HF source Wireless communication devices	Transmitter frequency [MHz]	Test Frequency [MHz]	Maximum Power P [W]	Distance d [m]
Various Transmitter devices (TETRA 400)	380-390	385	1.8	0.3
- Walkie-talkie (FRS) - Emergency services, Police, Fire, Maintenance (GMRS)	430-470	450	2	0.3
L TE (Long Term Evolution) Band 13/17	704-707	710/745/780	0.2	0.3
- GSM800/900 - LTE band 5 - Mobile telephone CT1+, CT2,CT3	800-960	810/870/930	2	0.3
- GSM1800/1900 - DECT (mobile telephone) - LTE Band 1/3/4/25 - UMTS (Universal Mobile Telecommunications System)	1700-1990	1720/1845/1970	2	0.3
- Bluetooth, WLAN 802.11b/g/n - LTE Band 7 - RFID 2450 (active & passive transponder and readers)	2400-2570	2450	2	0.3
WLAN 802.11a/n	5100-5800	5240/5500/5785	0.2	0.3

⚠ CAUTION

▲   Portable HF telecommunications equipment must not be used within 0.3 metres of the CARDIOVIT AT-180 including the wiring.

▲   Do not operate the CARDIOVIT AT-180 near electrical / electronic devices and keep sufficient distance to all electrical devices.

For permanently installed HF telecommunications equipment (for example, radio and TV transmitters), the minimum distance to the transmitter can be calculated using the following formula: $d = 0.6 \times \sqrt{P}$.

d = recommended minimum distance in metres

P = radiated power in watts

(Formula based on the maximum immunity level of 10 V/m in the frequency range from 80 MHz to 3000 MHz).

i   For more information on operation in an electromagnetic environment according to IEC/EN 60601-1-2, please consult the CARDIOVIT AT-180 service manual.

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